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(54) **METHODS AND APPARATUS FOR MIXING AND SHIPPING FLUIDS**

(75) Inventors: **Michael E. Goodwin**, Logan, UT (US);  
**Jacob D. Lee**, Smithfield, UT (US);  
**Whitt F. Woods**, North Ogden, UT (US);  
**Patrick L. Draper**, Smithfield, UT (US)

(73) Assignee: **Life Technologies Corporation**,  
Carlsbad, CA (US)

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(58) **Field of Classification Search**

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See application file for complete search history.

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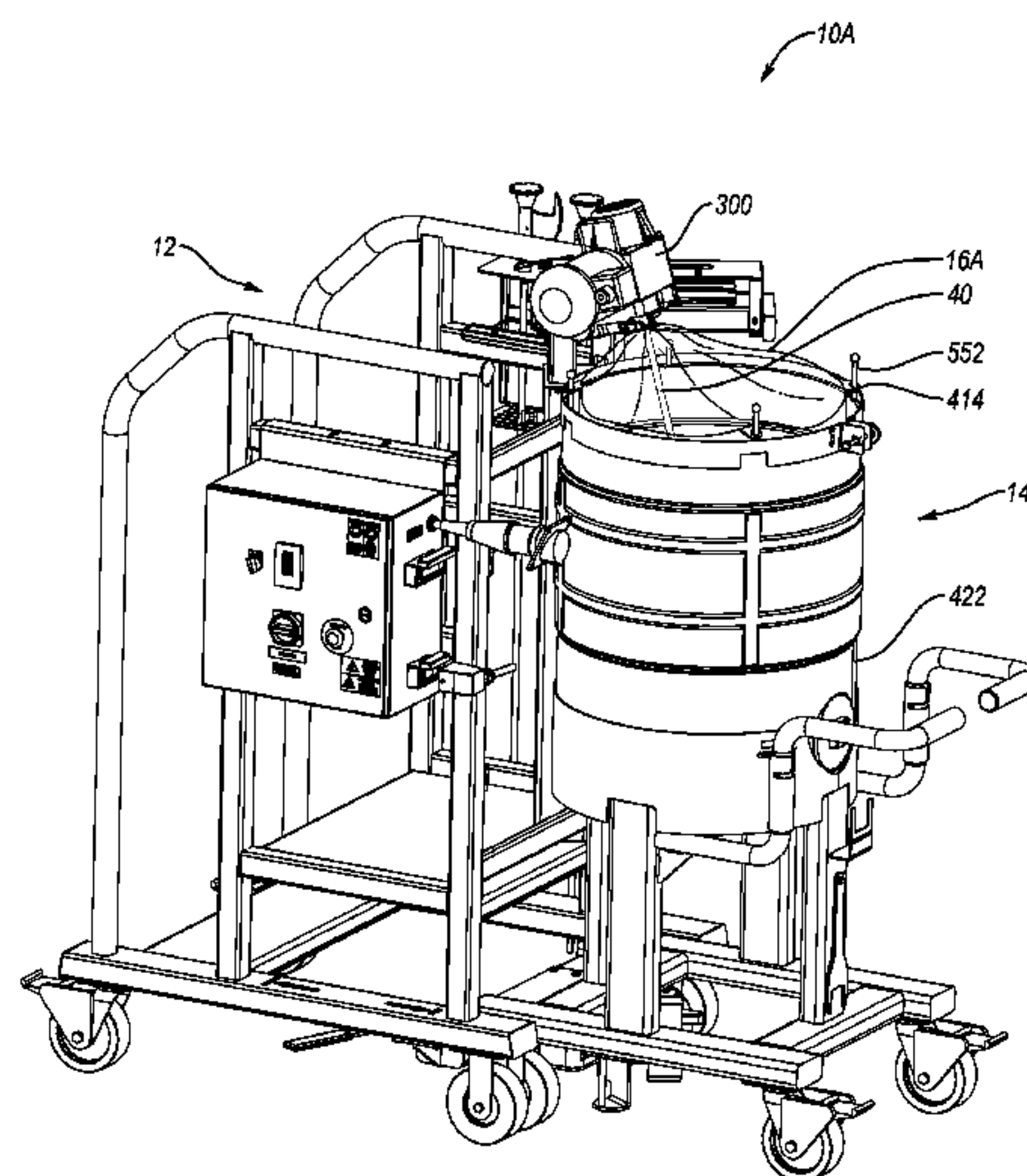
*Primary Examiner* — Christopher Harmon

(74) *Attorney, Agent, or Firm* — Workman Nydegger

(57) **ABSTRACT**

A method for mixing includes releasably coupling a first container station to a docking station, the first container station having a shipping vessel bounding a compartment, the docking station having a stand and a drive motor assembly adjustably mounted to the stand. The vertical or horizontal position of the drive motor assembly is adjusted relative to the stand so that the drive motor assembly is in a first position. A drive shaft is advanced through the drive motor assembly and into a chamber of a first collapsible bag disposed within the compartment of the shipping vessel. The drive motor assembly is activated so that the mixer rotates the drive shaft causing mixing of the fluid within the first collapsible bag.

**21 Claims, 23 Drawing Sheets**



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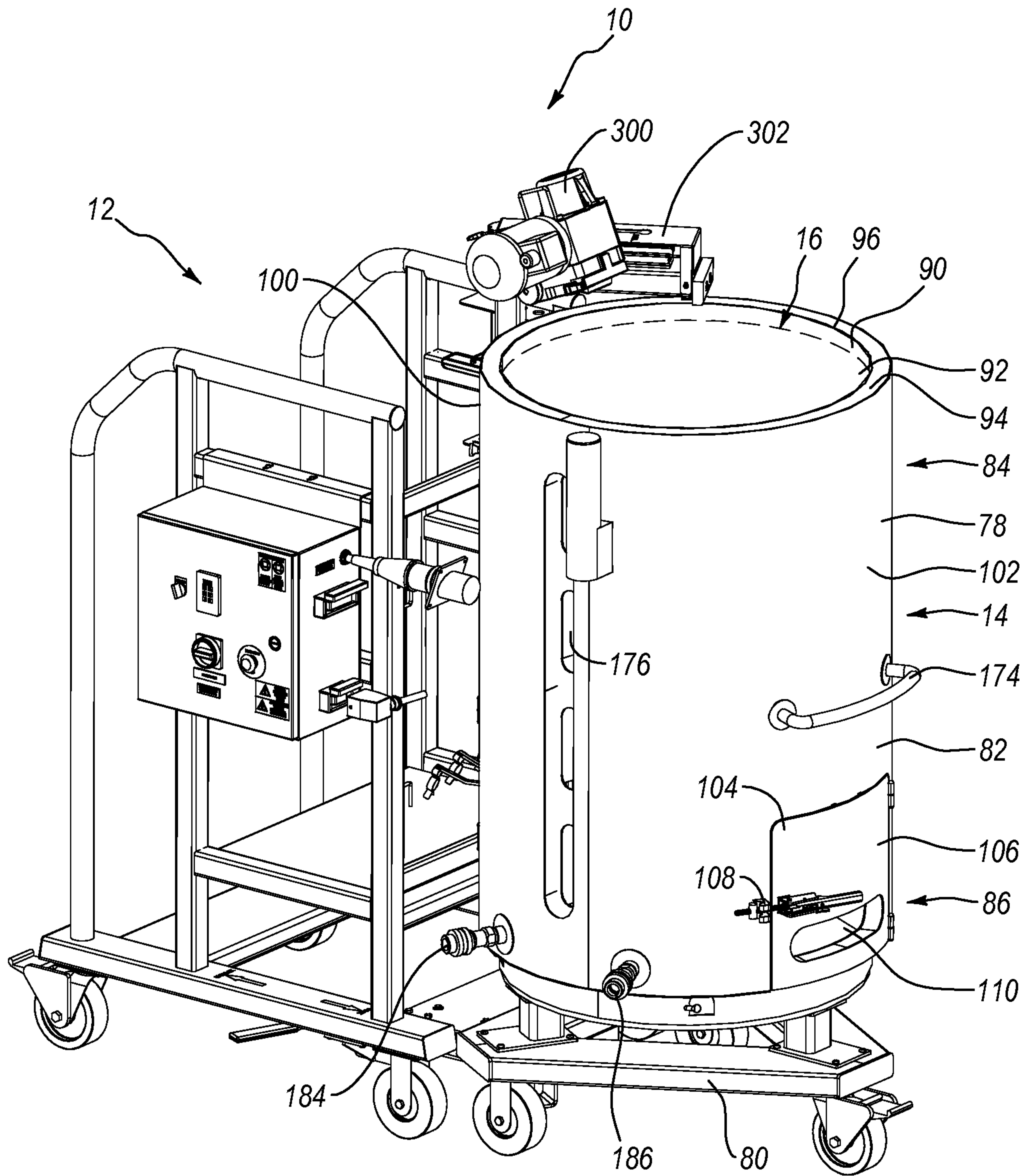


Fig. 1



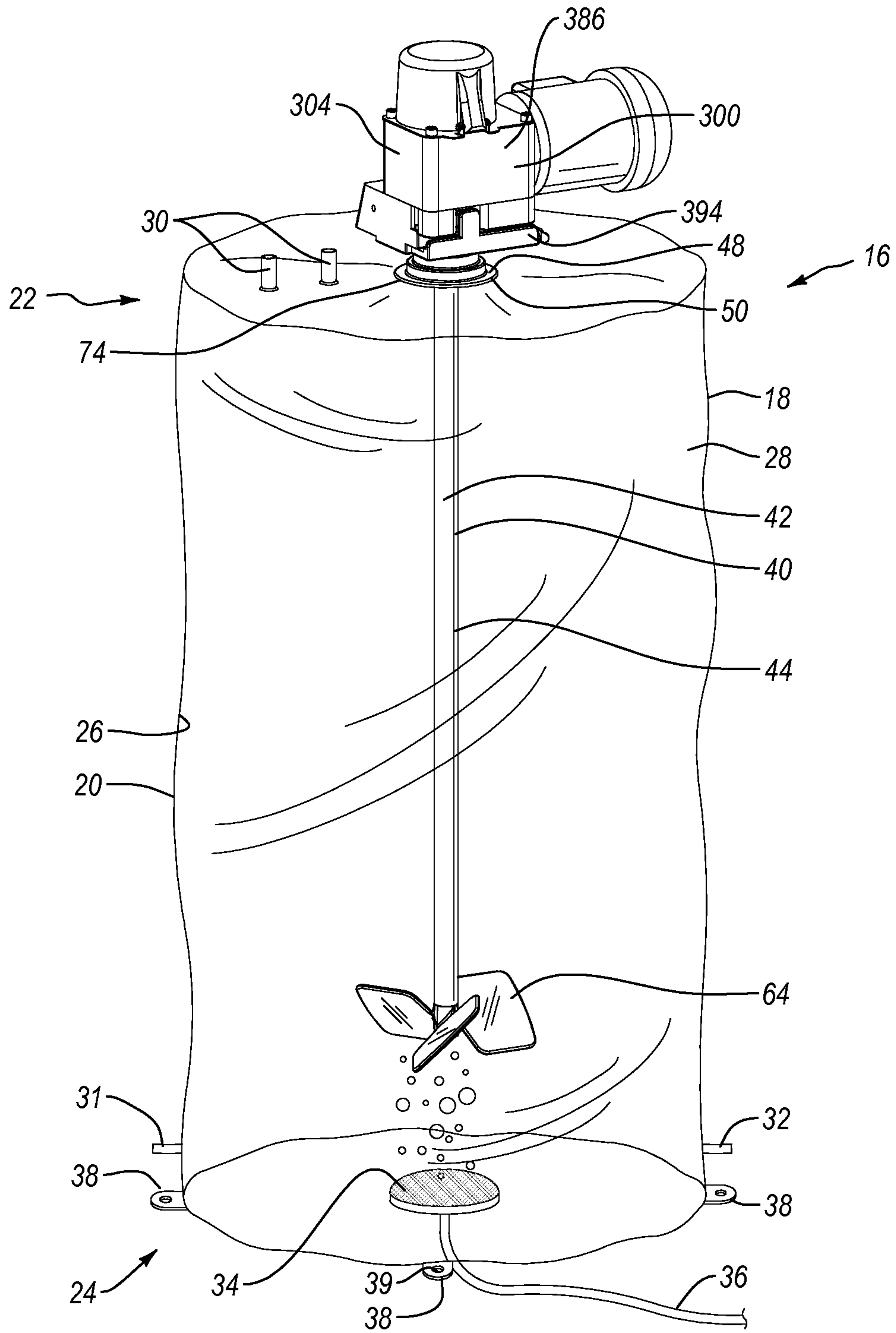


Fig. 2

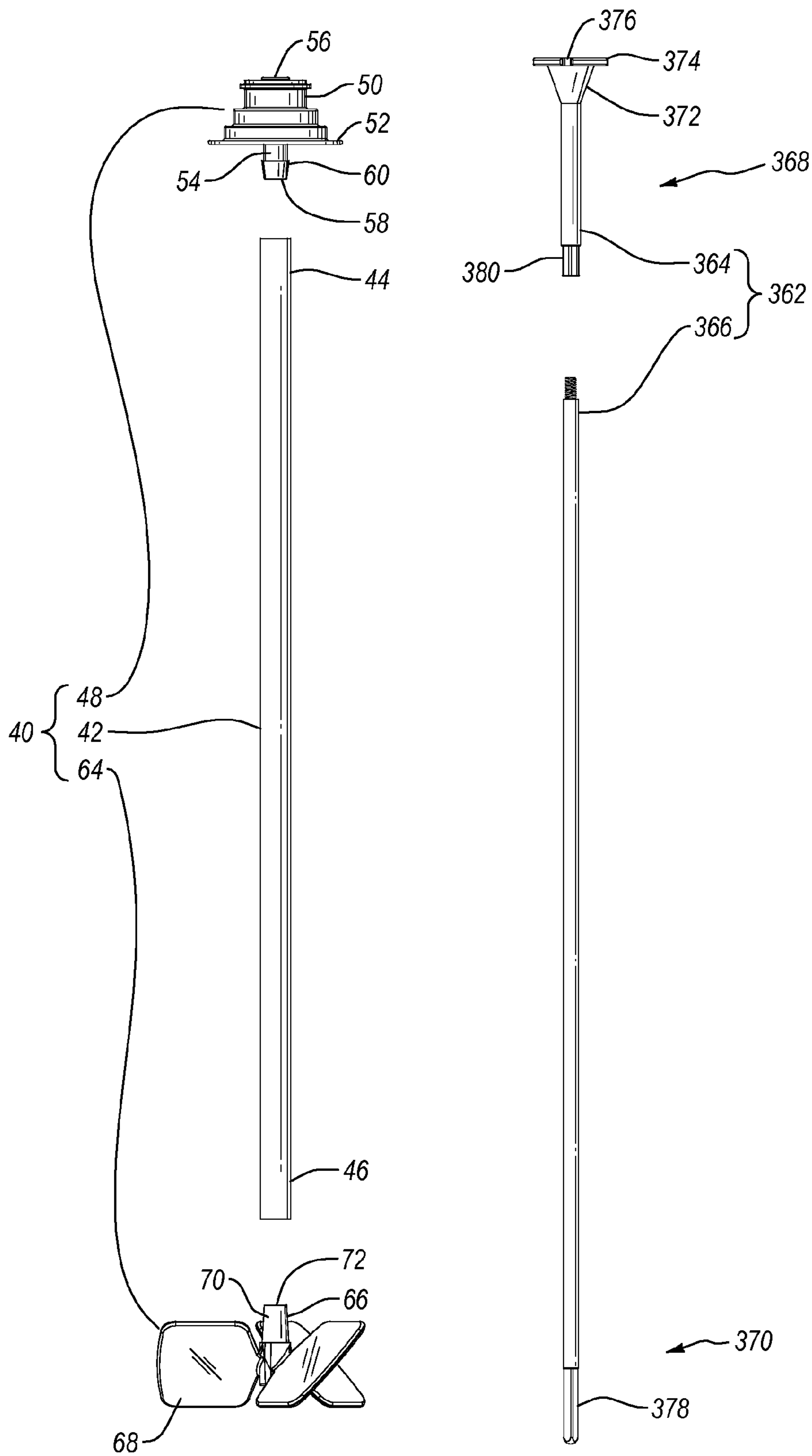


Fig. 3

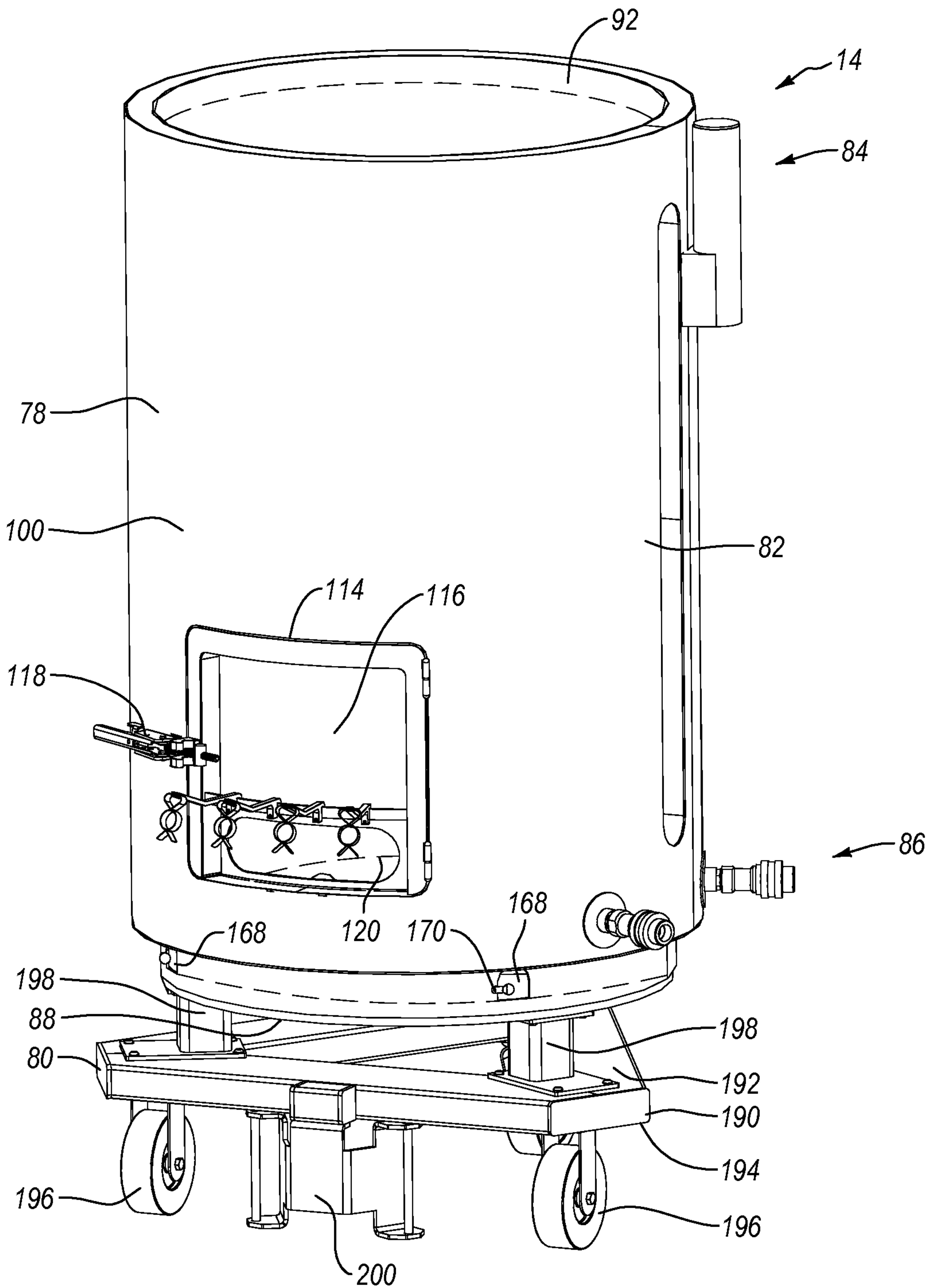


Fig. 4

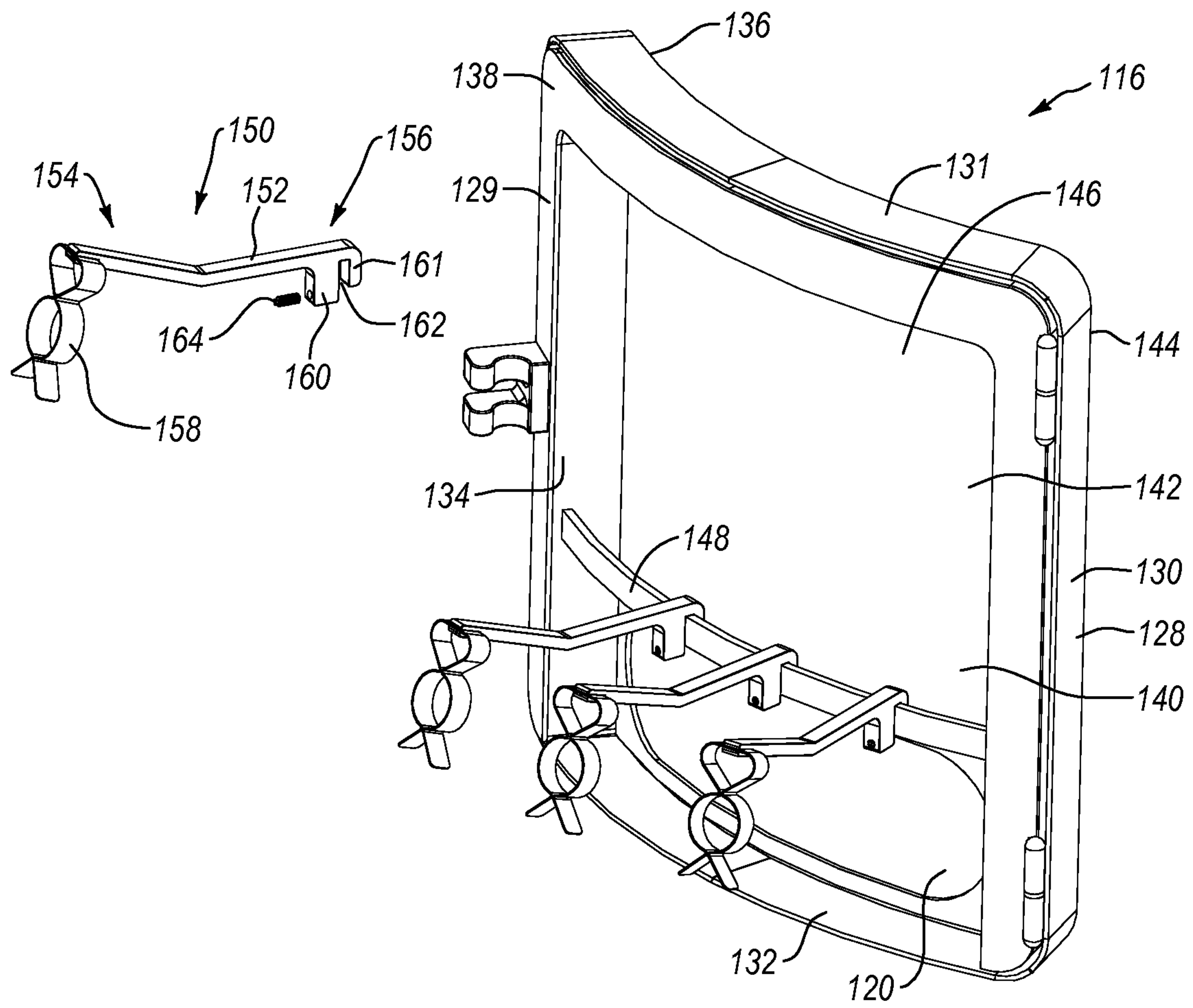


Fig. 5

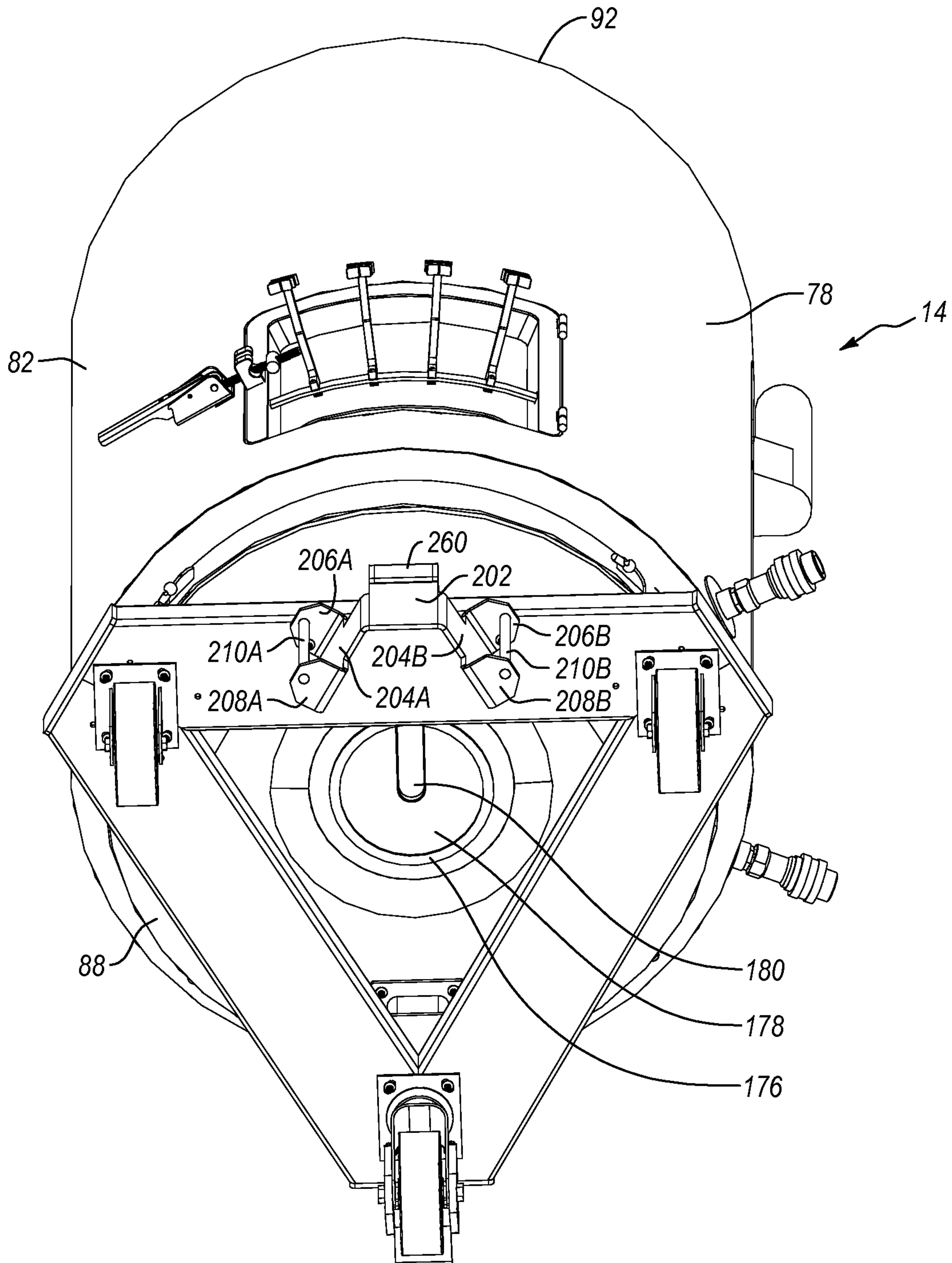


Fig. 6



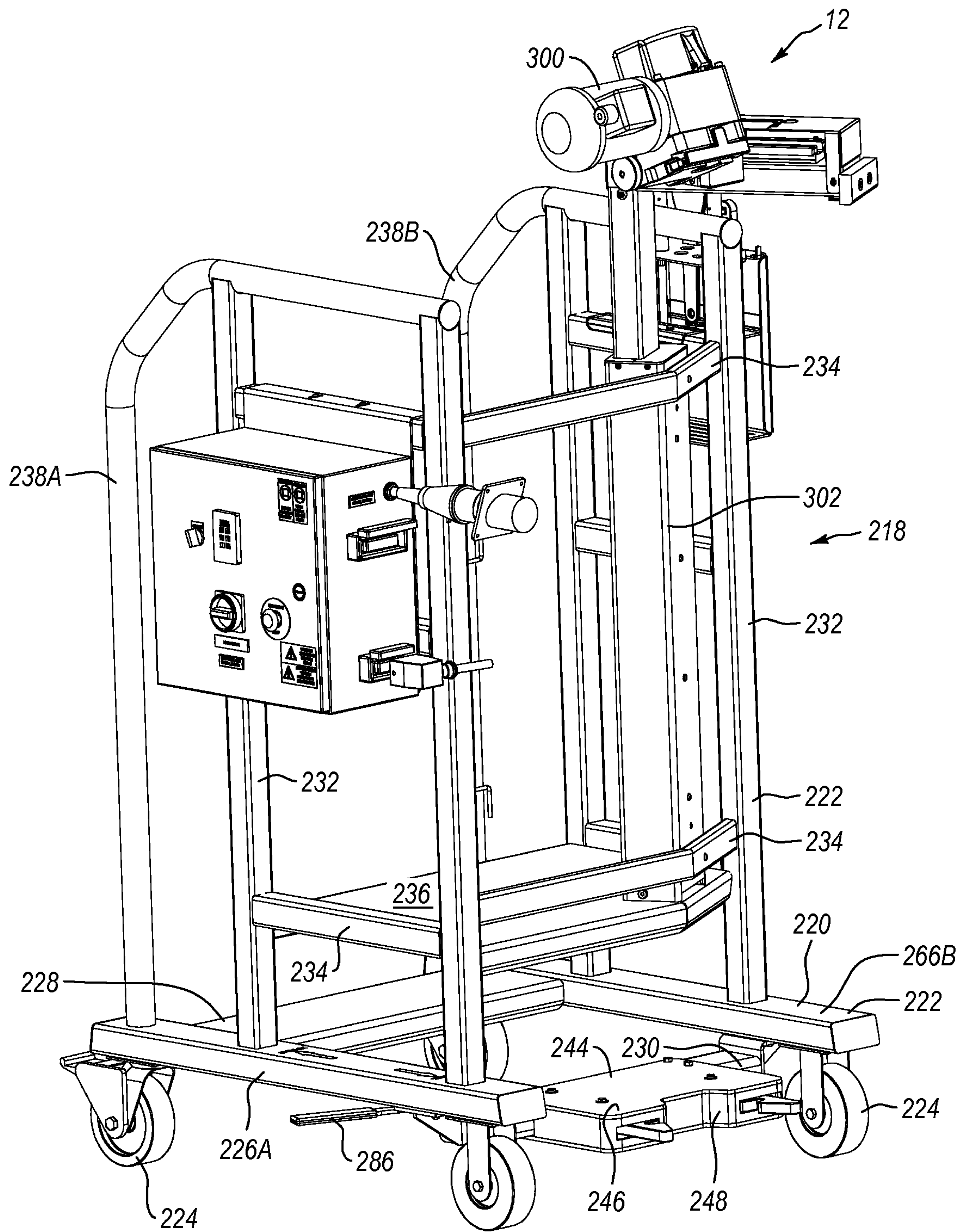
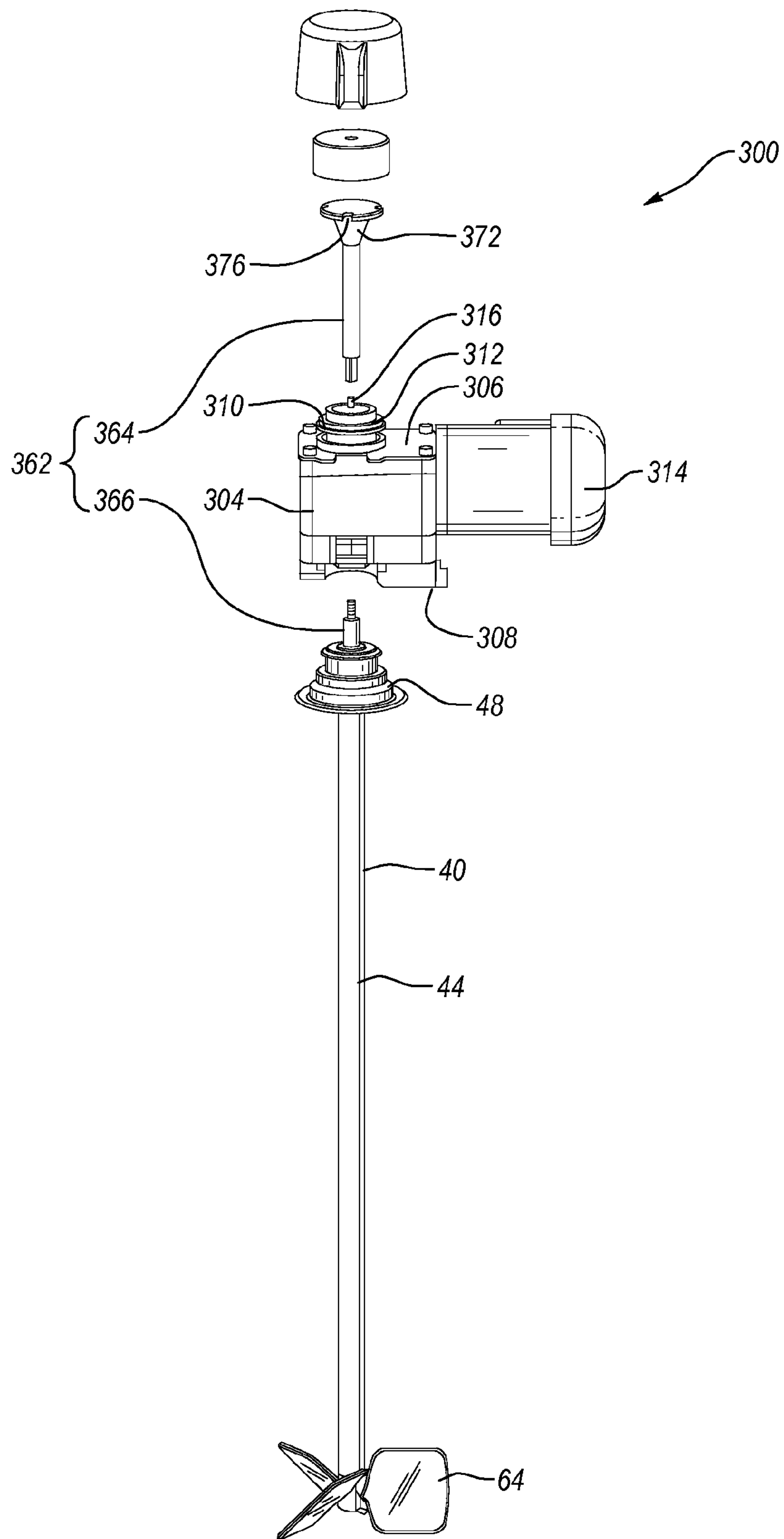


Fig. 7





**Fig. 9**

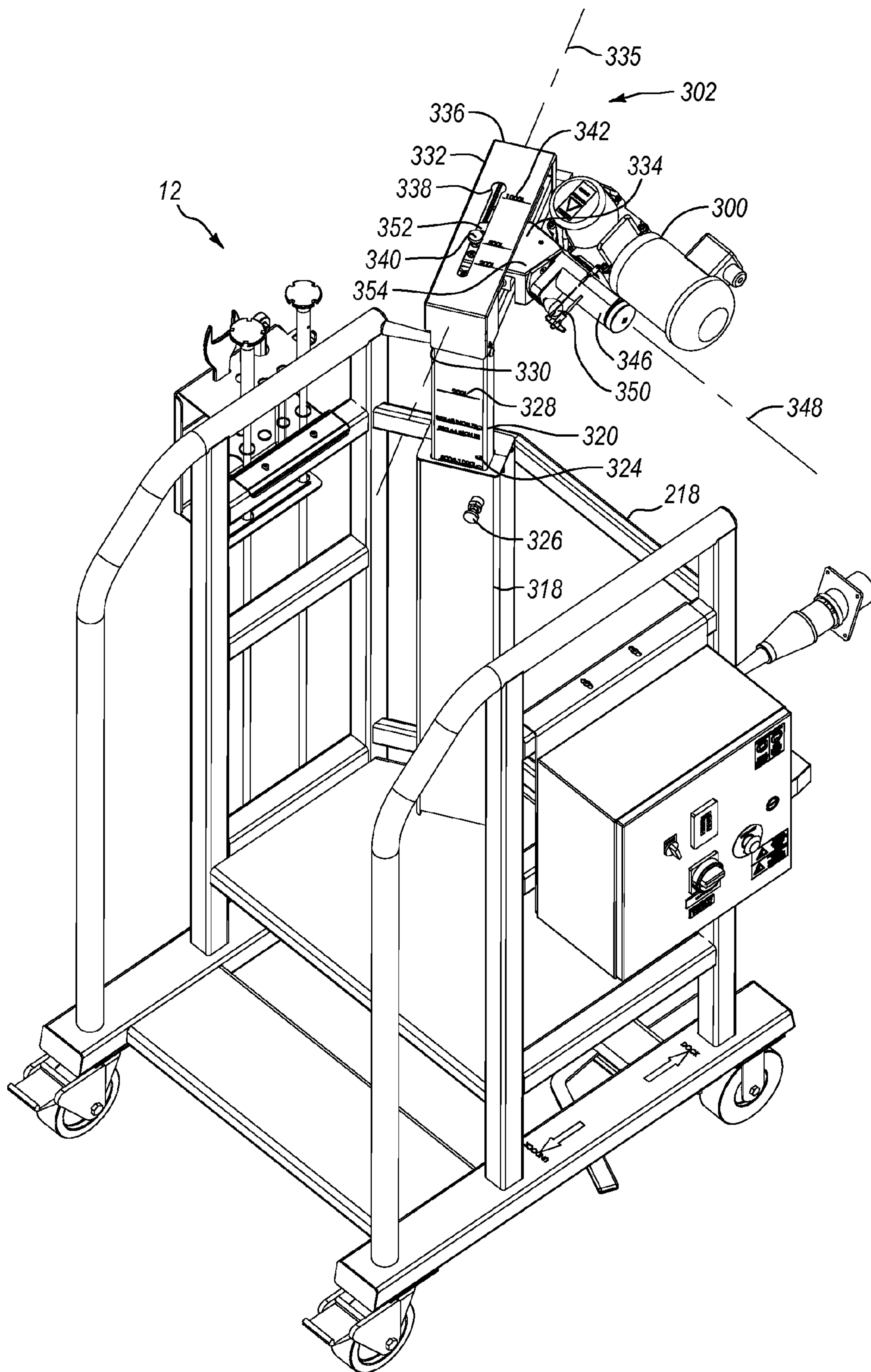


Fig. 10



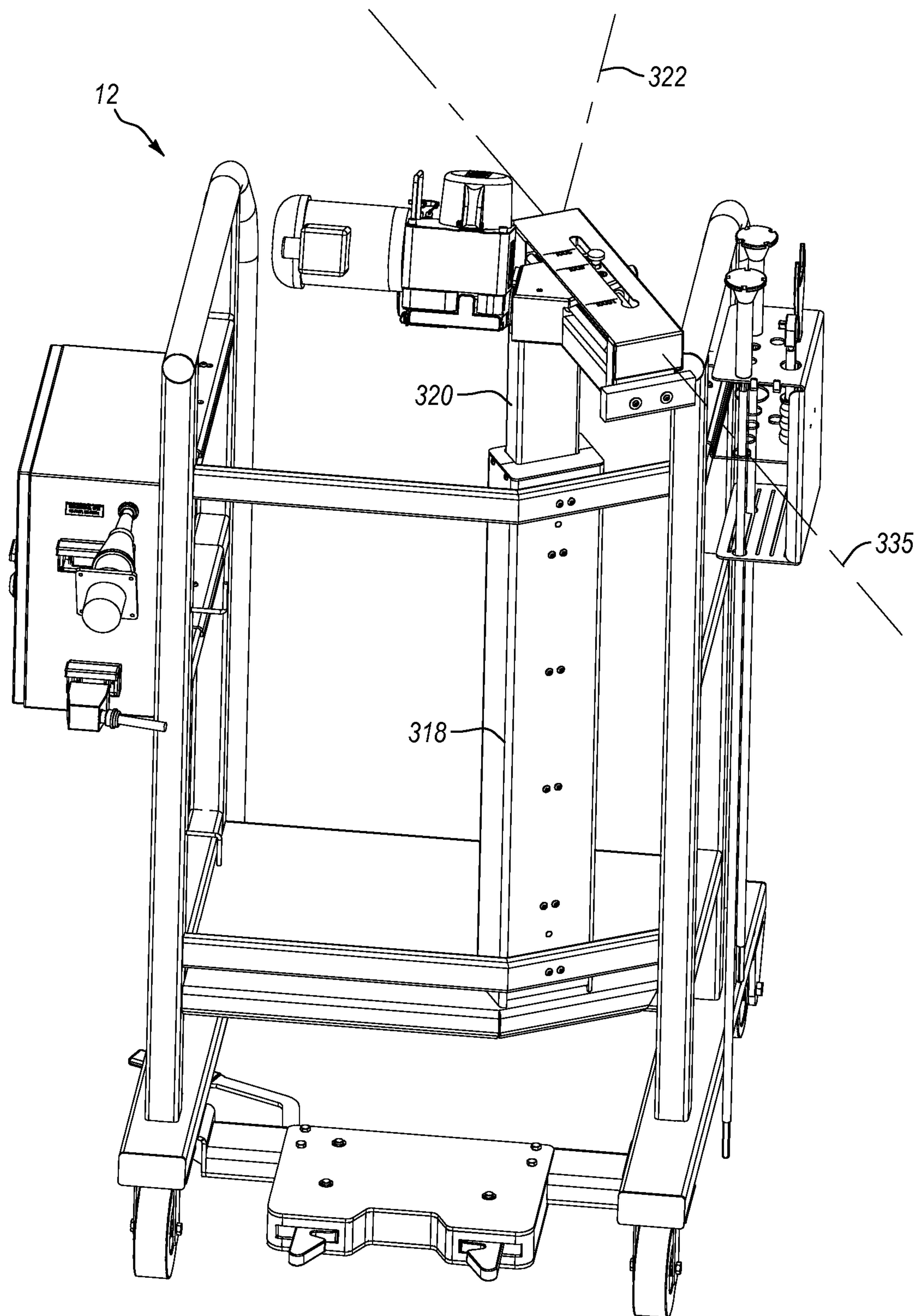


Fig. 11

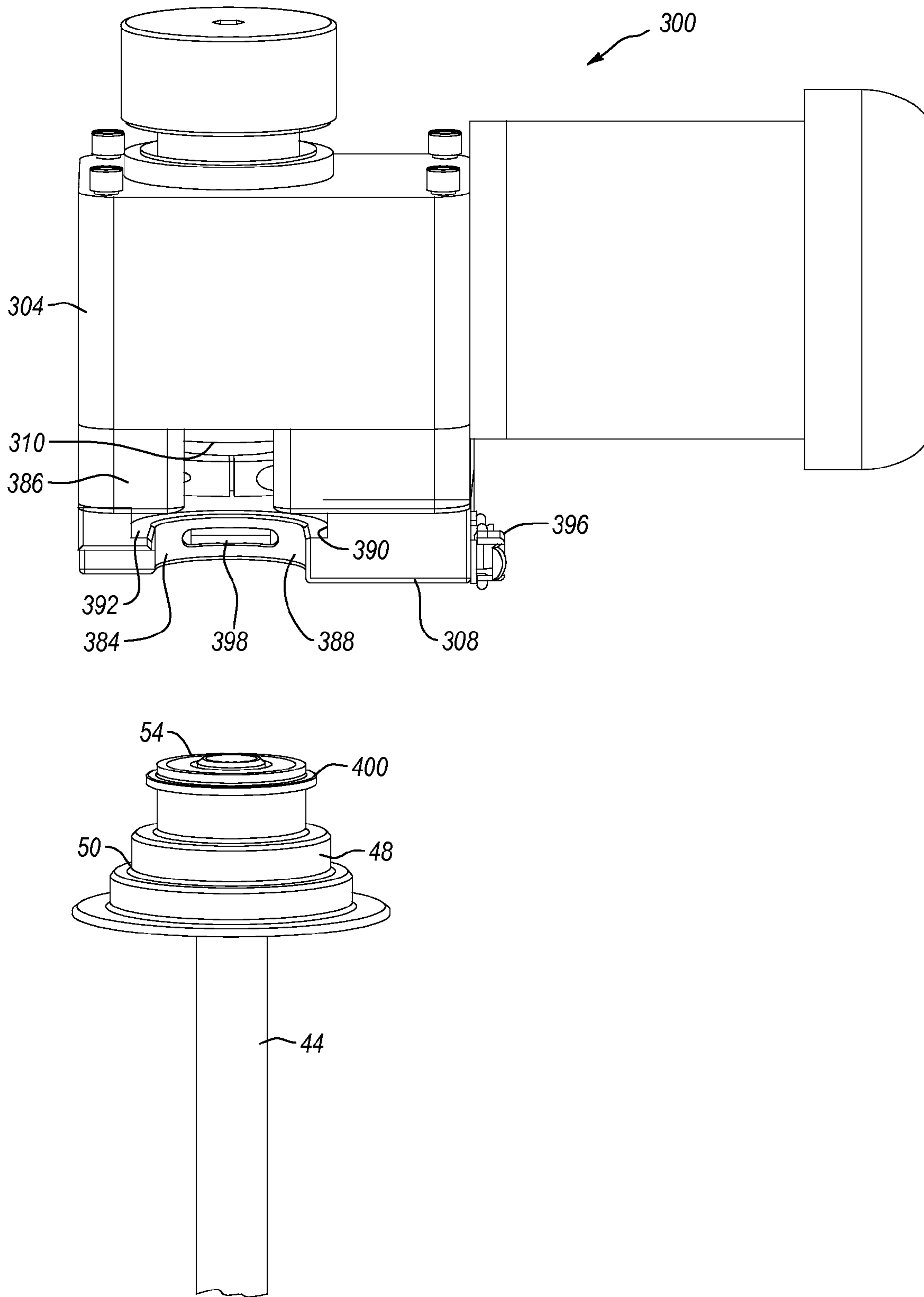
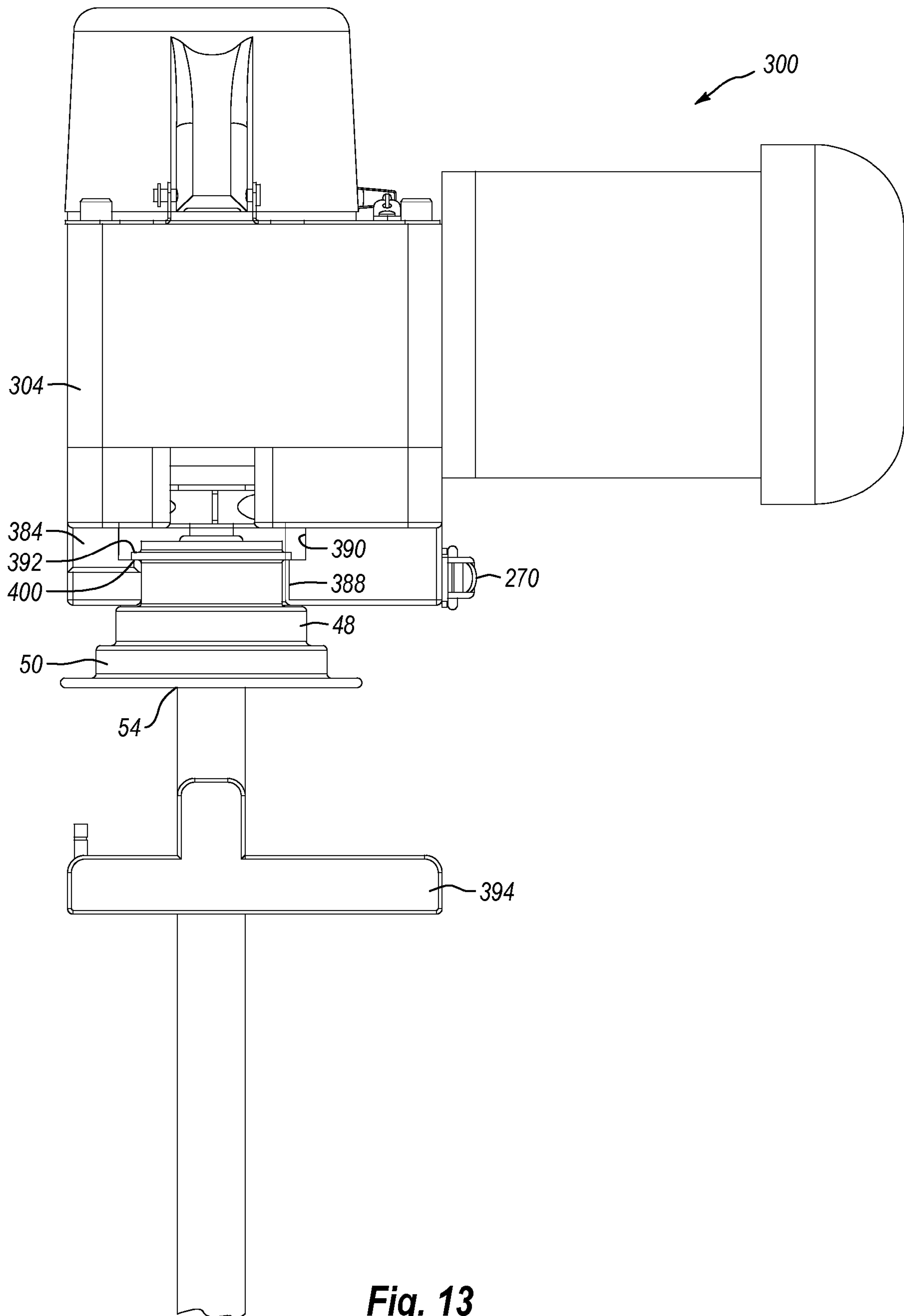


Fig. 12



**Fig. 13**

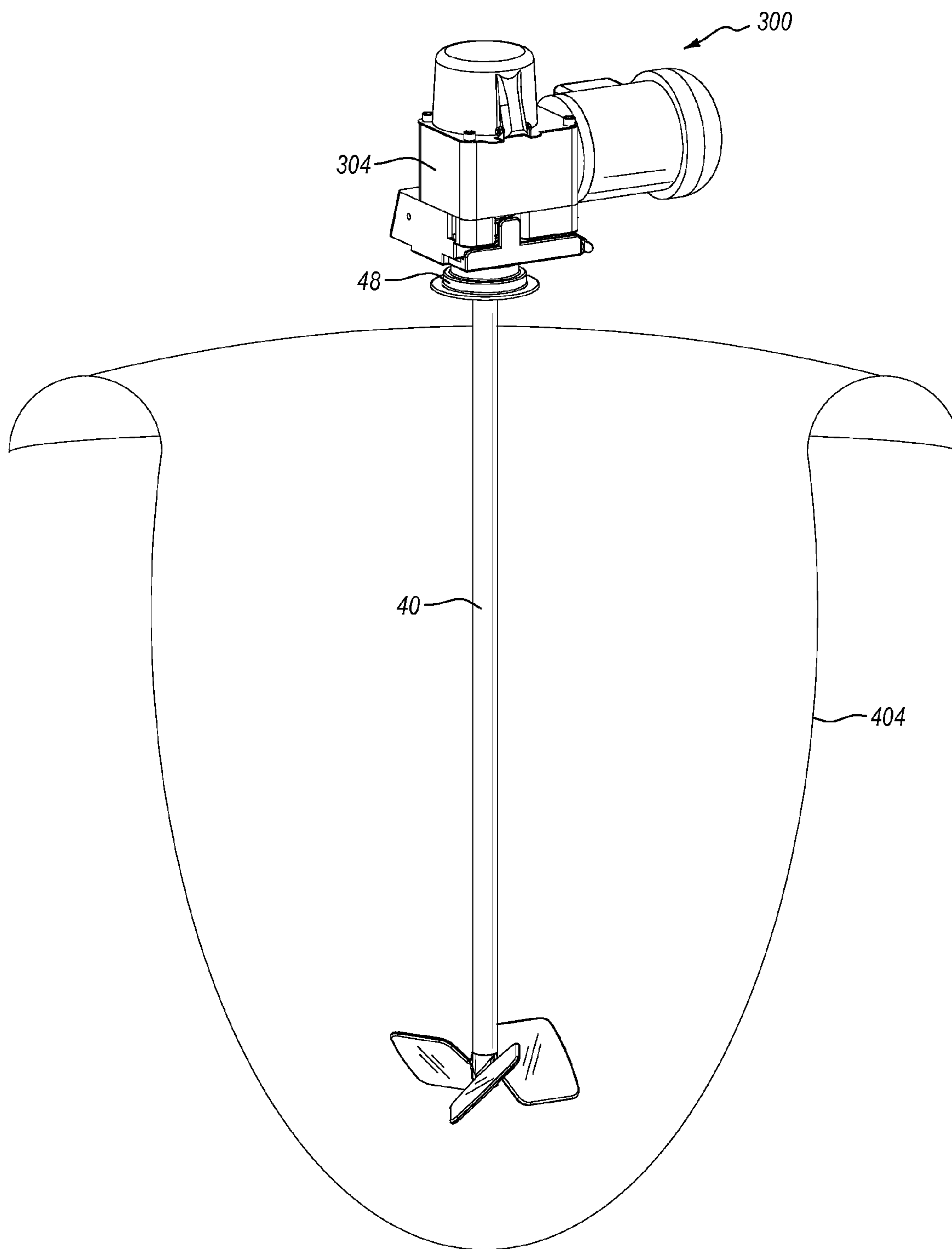
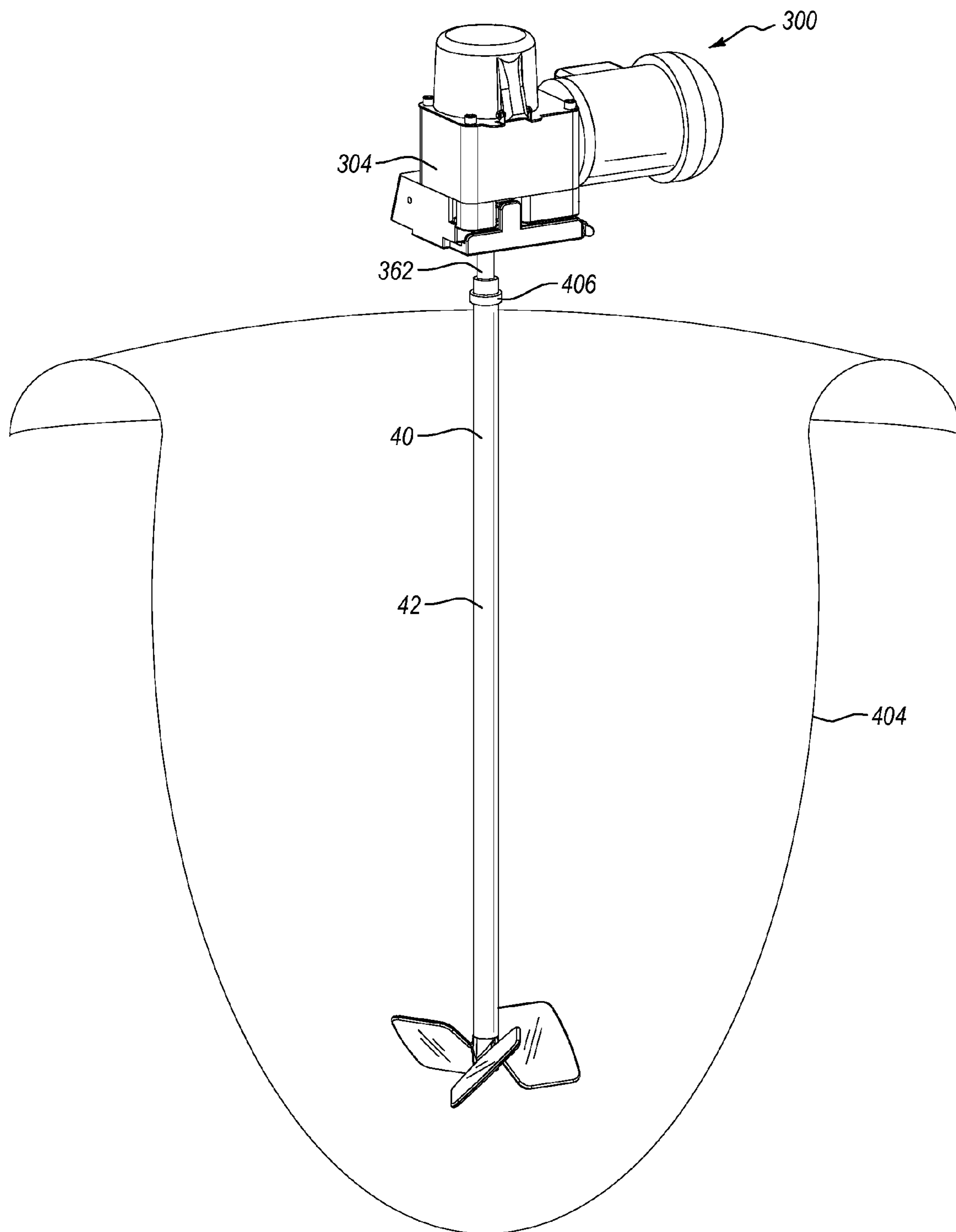


Fig. 14





**Fig. 15**

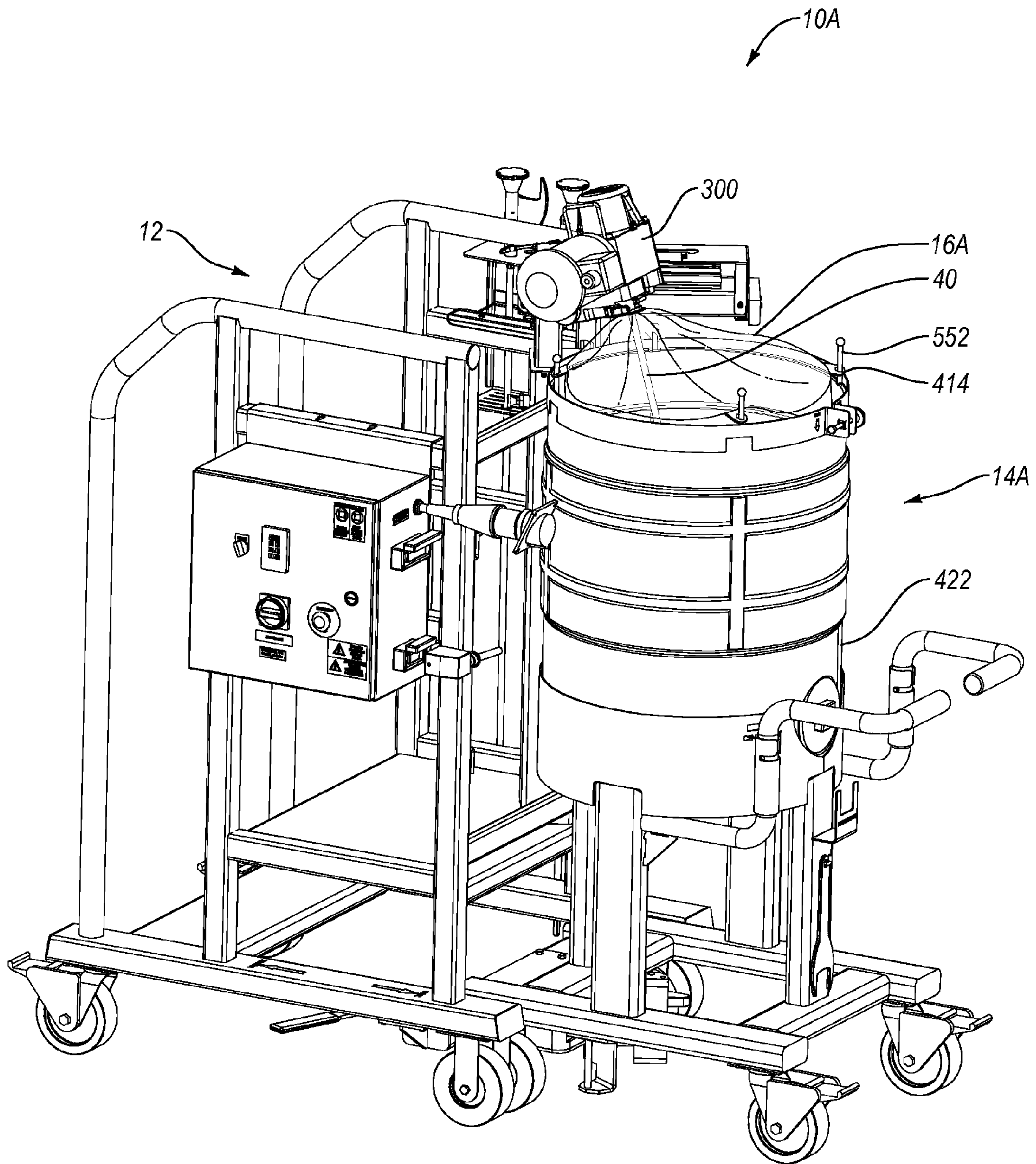


Fig. 16

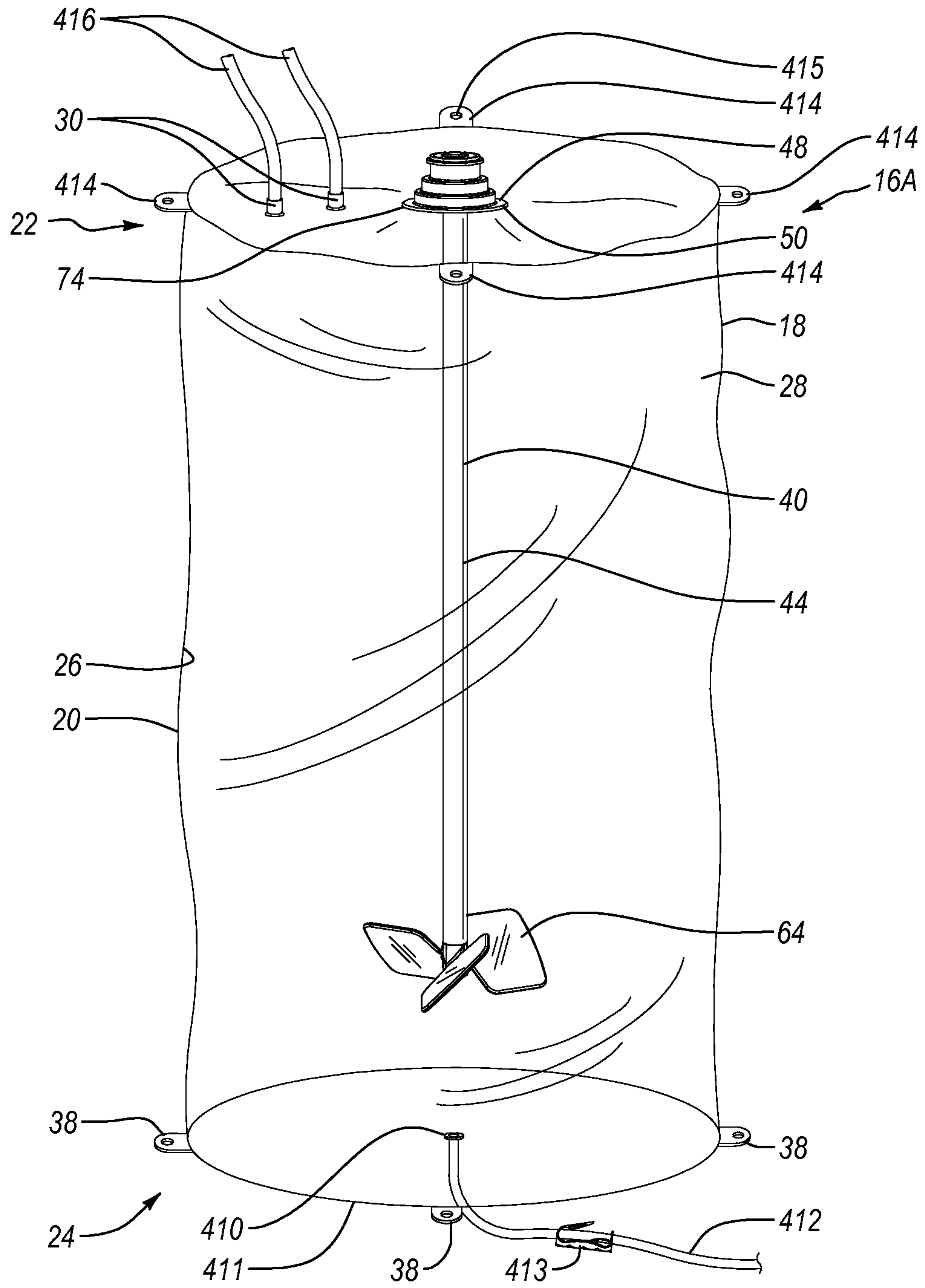


Fig. 17

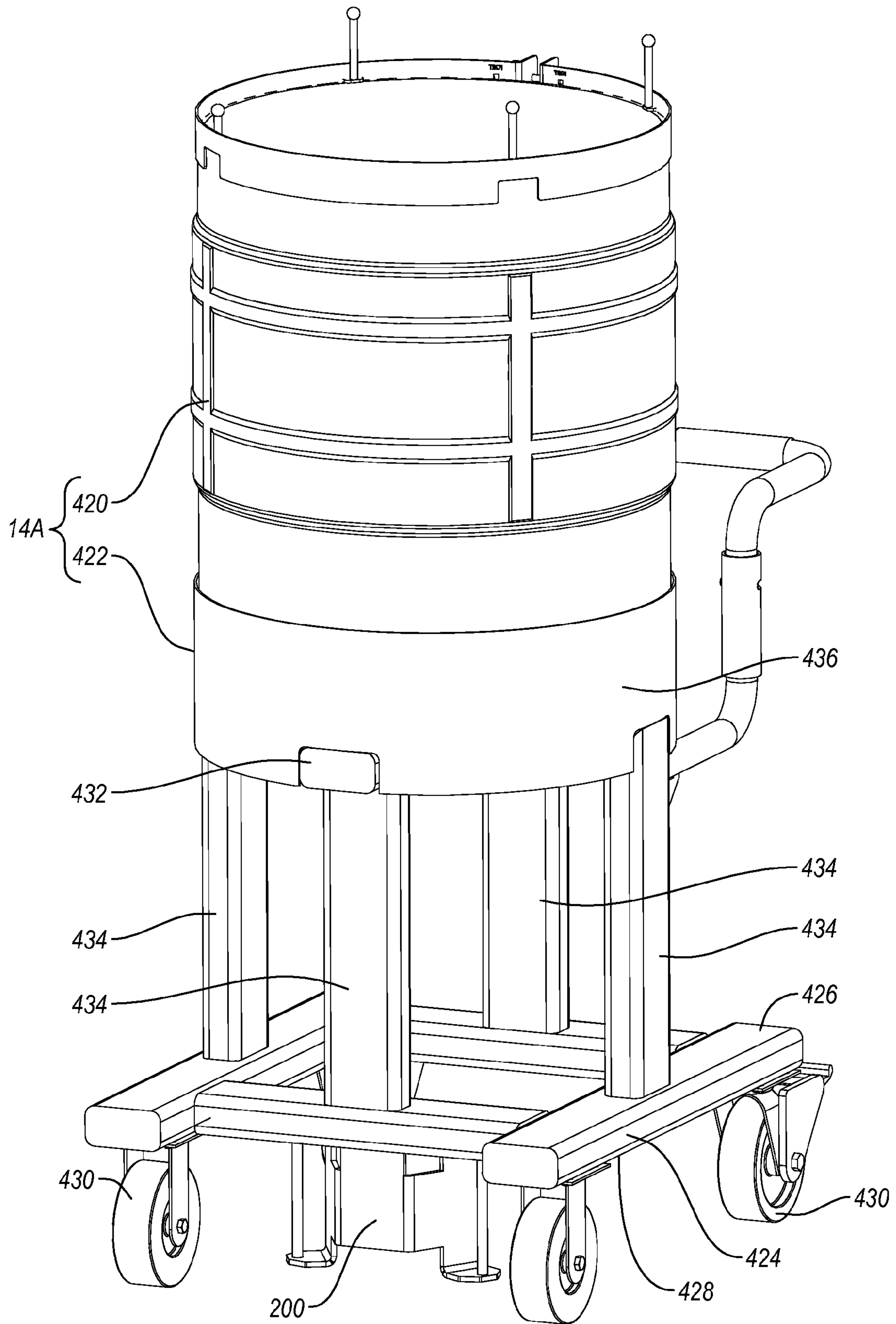


Fig. 18



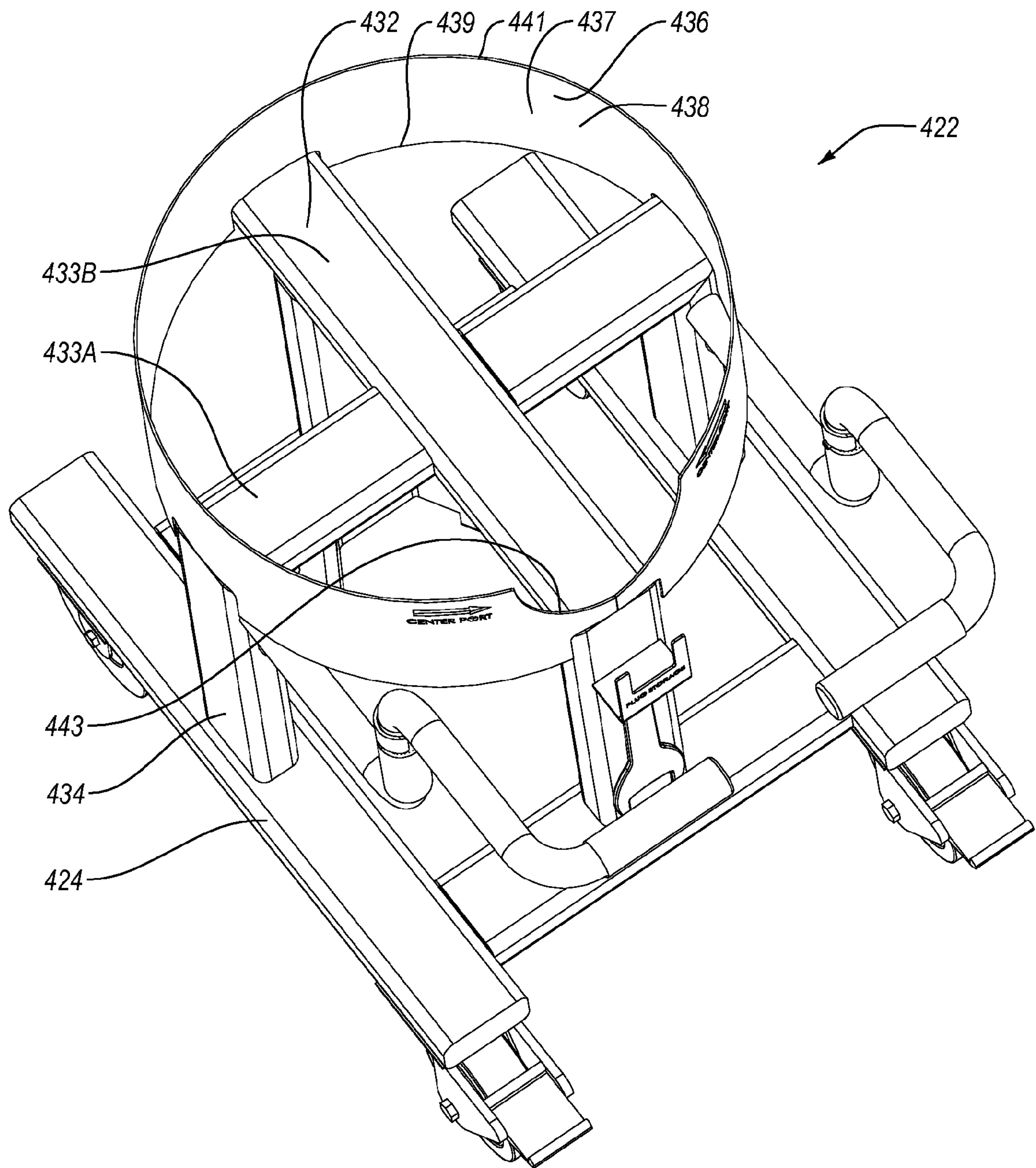


Fig. 19

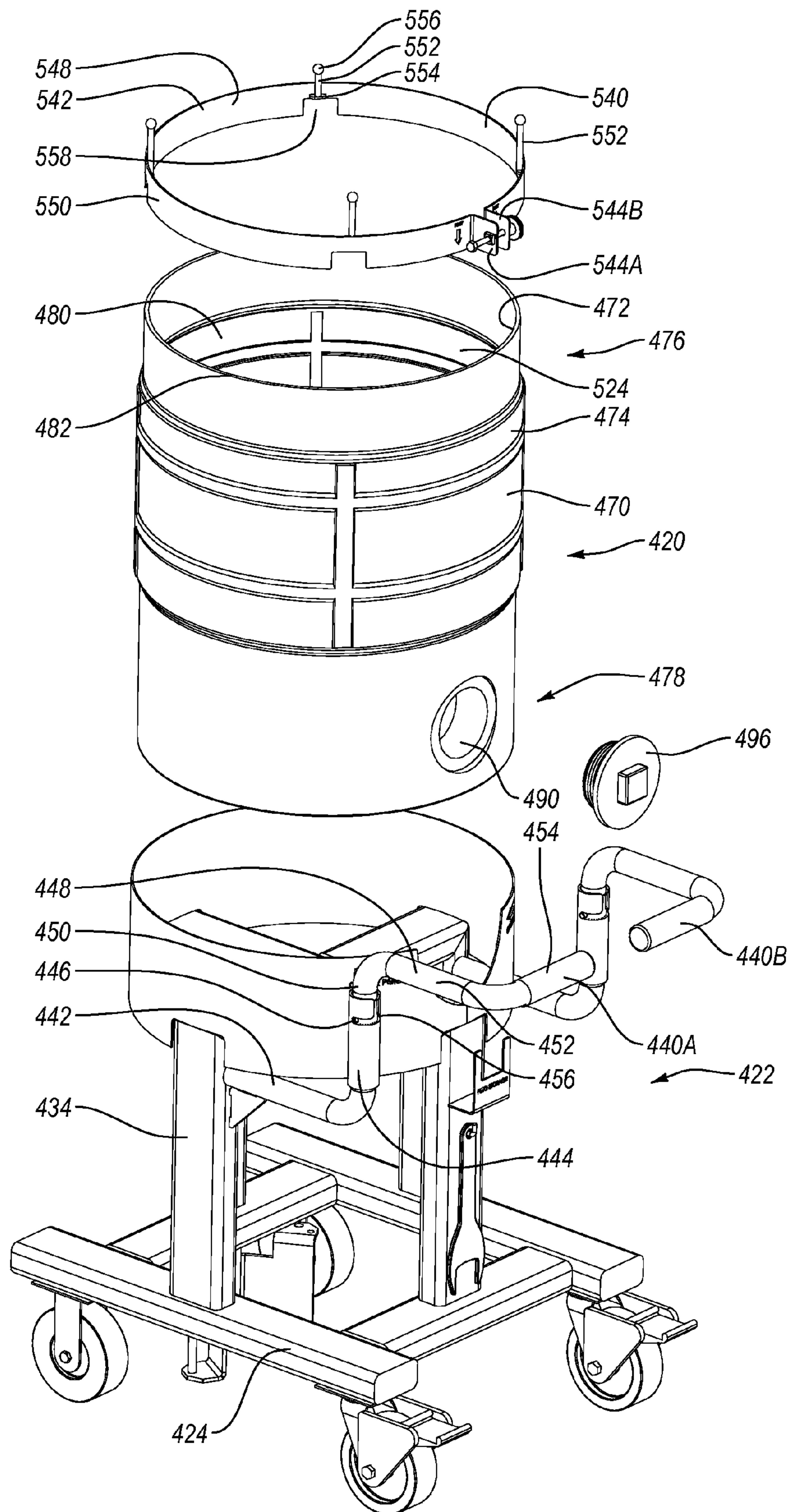


Fig. 20

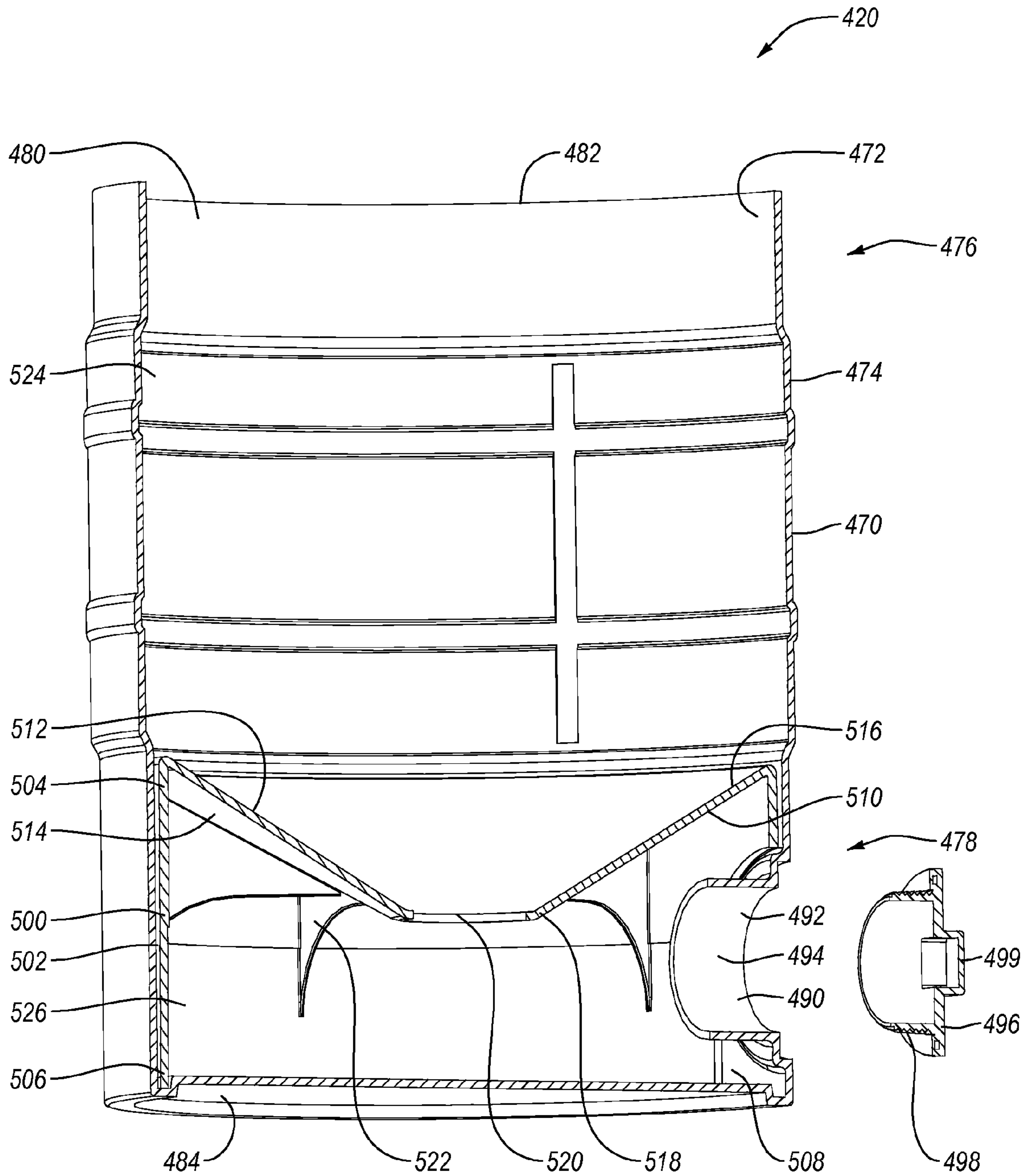


Fig. 21



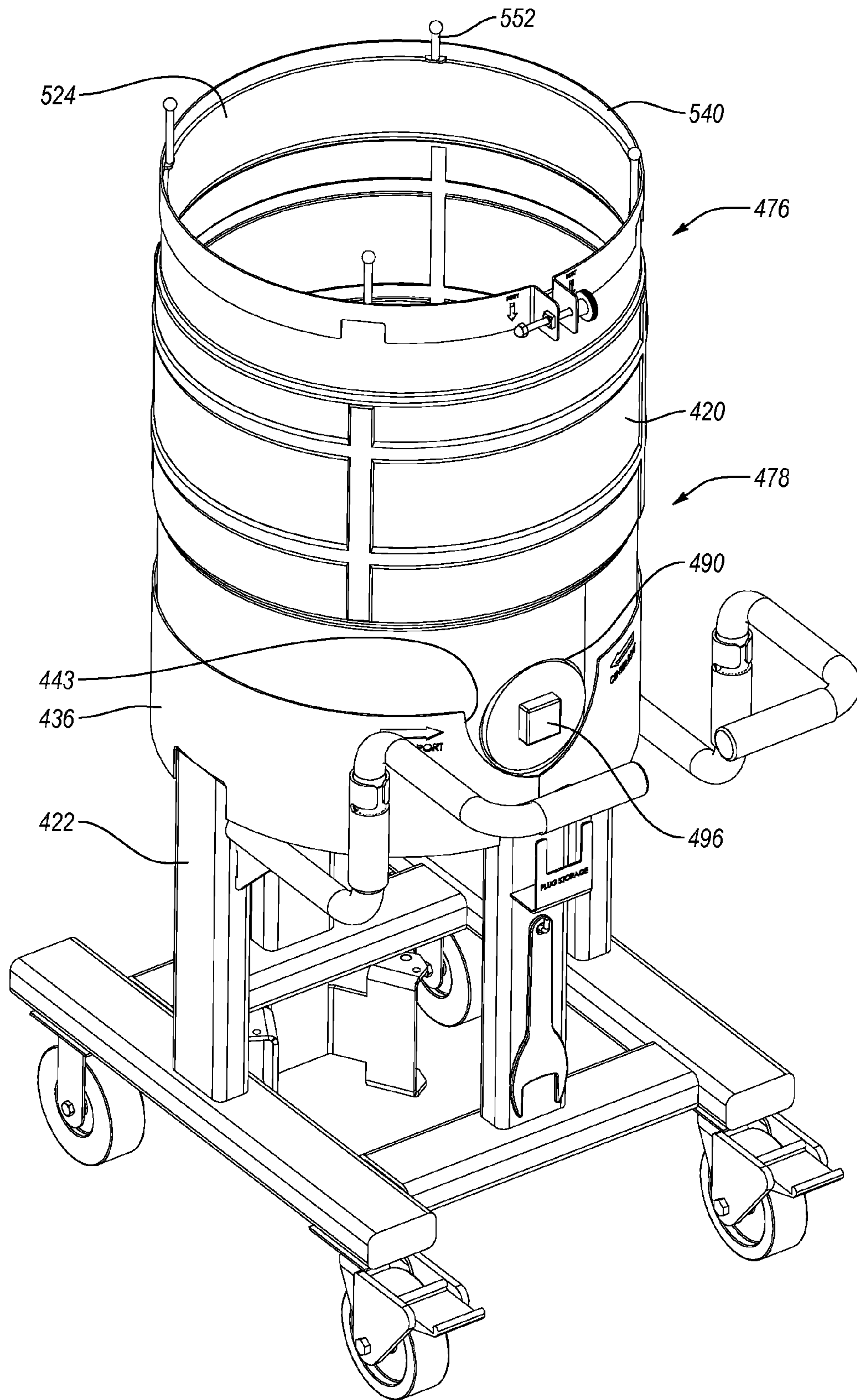
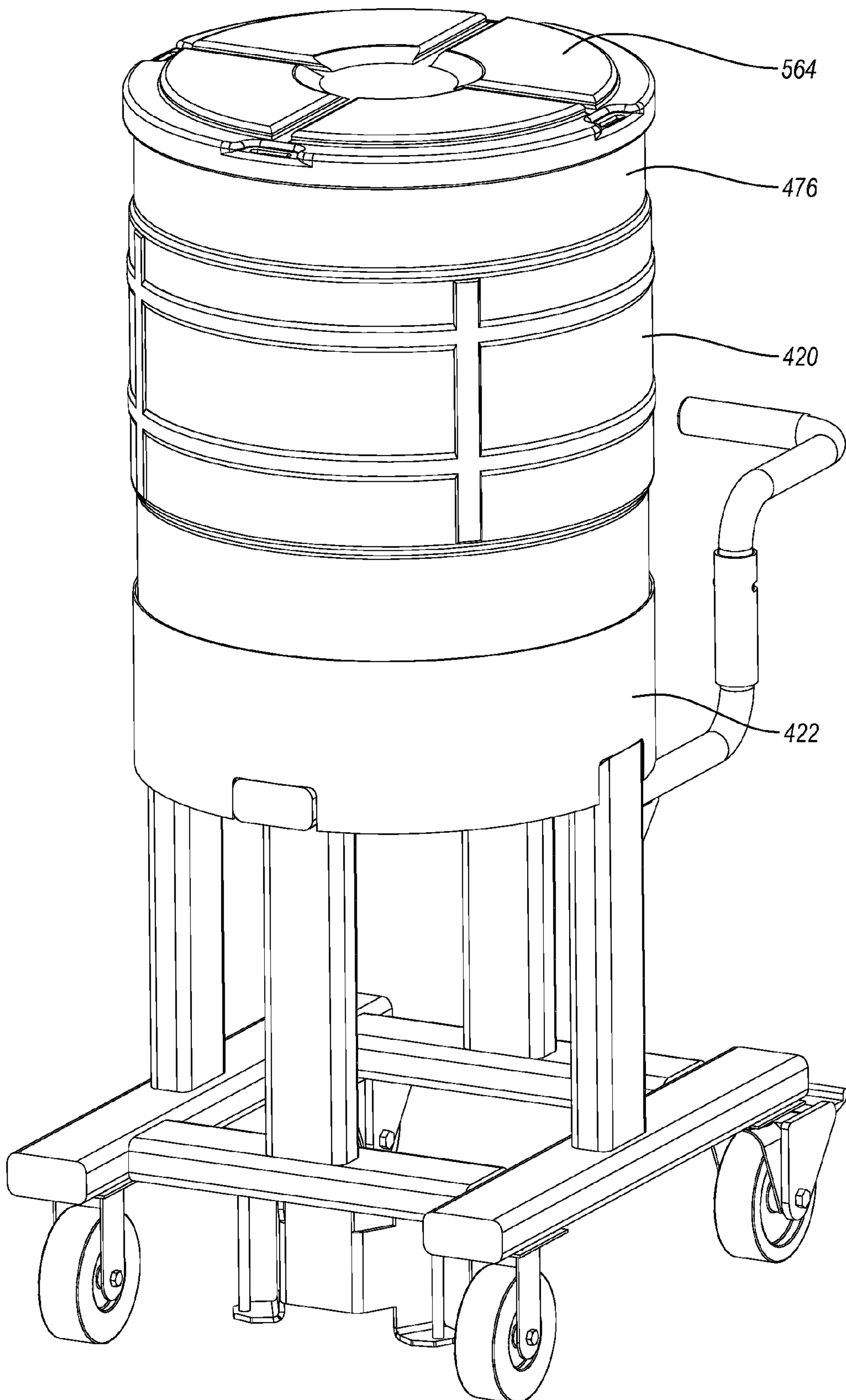


Fig. 22





**Fig. 23**

**1****METHODS AND APPARATUS FOR MIXING  
AND SHIPPING FLUIDS****CROSS-REFERENCE TO RELATED  
APPLICATIONS**

Not applicable.

**BACKGROUND OF THE INVENTION****1. The Field of the Invention**

The present invention relates to methods and systems for mixing and shipping fluids, namely, biological fluids.

**2. The Relevant Technology**

The biopharmaceutical industry uses a broad range of mixing systems for a variety of processes such as in the preparation of media and buffers and in the growing of cells and microorganisms in bioreactors. Many conventional mixing systems, including bioreactors, comprise a rigid tank that can be sealed closed. A drive shaft with impeller is rotatably disposed within the tank. The impeller functions to suspend and mix the components.

In many cases, great care must be taken to sterilize and maintain the sterility of the mixing system so that the culture or other product does not become contaminated. Accordingly, between the production of different batches, the mixing tank, mixer, and all other reusable components that contact the processed material must be carefully cleaned to avoid any cross contamination. The cleaning of the structural components is labor intensive, time consuming, and costly. For example, the cleaning can require the use of chemical cleaners such as sodium hydroxide and may require steam sterilization as well. The use of chemical cleaners has the additional challenge of being relatively dangerous, and cleaning agents can be difficult and/or expensive to dispose of once used.

Furthermore, biological fluids are often produced in bulk at a manufacturing facility and then shipped in smaller quantities to customers for further processing or utilization. This process typically entails manufacturing a fluid through use of a mixing process, dispensing the fluid into a transport container, and then shipping the transport container to a customer. The customer then dispenses the fluid into a further processing container so that the fluid can be remixed or resuspended so that the fluid is homogeneous prior to use. As can be appreciated, this transferring of fluids between different containers can be time consuming, labor intensive and run the risk of breaching sterility.

Accordingly, what is needed are mixing systems that require minimum cleaning or sterilization. What is also needed are systems that that can be used for preparing, transporting, and resuspending solutions that are simple to use and minimize in risk of breaching sterility.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Various embodiments of the present invention will now be discussed with reference to the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope.

FIG. 1 is a perspective view of a container station docked with a docking station;

FIG. 2 is a perspective view of a container assembly that is used with the container station shown in FIG. 1;

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FIG. 3 is an elevated side view of an impeller assembly forming part of the container assembly shown in FIG. 2 and a drive shaft;

FIG. 4 is a front perspective view of the container station shown in FIG. 1;

FIG. 5 is a perspective view of a door of the container station shown in FIG. 4;

FIG. 6 is a bottom perspective view of the container station shown in FIG. 4;

FIG. 7 is a front perspective view of the docking station shown in FIG. 1;

FIG. 8 is a top perspective view of the locking assembly shown in FIG. 7;

FIG. 9 is a partially disassembly perspective view of a drive motor assembly of the docking station shown in FIG. 7 in association with the impeller assembly and drive shaft;

FIG. 10 is a top perspective view of the docking station shown in FIG. 7;

FIG. 11 is an alternative perspective view of the docking station shown in FIG. 7;

FIG. 12 is a front perspective view of the drive motor assembly and rotational assembly;

FIG. 13 is an elevated front view of the rotational assembly shown in FIG. 12 coupled with the drive motor assembly;

FIG. 14 is a perspective view of an alternative embodiment of a container being used with a drive motor assembly and impeller assembly;

FIG. 15 is a perspective view of an alternative embodiment of the impeller assembly shown in FIG. 14.

FIG. 16 is a perspective view of one embodiment of a mixing system incorporating features of the present invention;

FIG. 17 is a perspective view of one embodiment of a container assembly that can be used in the mixing system shown in FIG. 16;

FIG. 18 is a front perspective view of the container assembly shown in FIG. 16;

FIG. 19 is a top perspective view of the cart of the container assembly shown in FIG. 18;

FIG. 20 is a partially exploded perspective view of the container assembly shown in FIG. 18;

FIG. 21 is a cross sectional side view of the shipping vessel of the container assembly shown in FIG. 18;

FIG. 22 is rear perspective view of the container assembly shown in FIG. 18; and

FIG. 23 is front perspective view of the container assembly shown in FIG. 18 having a lid mounted thereon.

**DETAILED DESCRIPTION OF THE PREFERRED  
EMBODIMENTS**

The present invention relates to systems and methods for mixing and, if desired, sparging solutions and/or suspensions. The systems can be commonly used as bioreactors or fermenters for culturing cells or microorganisms. By way of example and not by limitation, the inventive systems can be used in culturing bacteria, fungi, algae, plant cells, animal cells, protozoans, nematodes, and the like. The systems can accommodate cells and microorganisms that are aerobic or anaerobic and are adherent or non-adherent. The systems can also be used in association with the formation and/or treatment of solutions and/or suspensions that are for biological purposes, such as media, buffers, or reagents. For example, the systems can be used in the formation of media where sparging is used to control the pH of the media through adjustment of the carbonate/bicarbonate levels with controlled gaseous levels of carbon dioxide. The systems can also



be used for mixing powders or other components into a liquid where sparging is not required and/or where is solution is not for biological purposes. In addition, alternative embodiments of the present invention can be used for initially mixing solutions, such as the above, followed by shipping and then remixing or suspending the solution once it has reached a desired destination.

The inventive systems are designed so that a majority of the system components that contact the material being processed can be disposed of after each use. As a result, the inventive systems substantially eliminate the burden of cleaning and sterilization required by conventional stainless steel mixing systems. This feature also ensures that sterility can be consistently maintained during repeated processing of multiple batches. The inventive systems are also adjustable so that they can be used for mixing a variety of different batch sizes. In view of the foregoing, and the fact that the inventive systems are easily scalable, relatively low cost, and easily operated, the inventive systems can be used in a variety of industrial and research facilities that previously outsourced such processing.

Depicted in FIG. 1 is one embodiment of an inventive system 10 incorporating features of the present invention. In general, system 10 comprises a docking station 12, a container station 14 that removably docks with docking station 12, a container assembly 16 (FIG. 2) that is supported by container station 14, and a drive shaft 362 (FIG. 3) that extends between docking station 12 and container assembly 16. Container assembly 16 houses the solution or suspension that is mixed. The various components of system 10 will now be discussed in greater detail.

As depicted in FIG. 2, container assembly 16 comprises a container 18 having a side 20 that extends from an upper end 22 to an opposing lower end 24. Container 18 also has an interior surface 26 that bounds a compartment 28. Compartment 28 is configured to hold a fluid. In the embodiment depicted, container 18 comprises a flexible bag that is comprised of a flexible, water impermeable material such as a low-density polyethylene or other polymeric sheets having a thickness in a range between about 0.1 mm to about 5 mm with about 0.2 mm to about 2 mm being more common. Other thicknesses can also be used. The material can be comprised of a single ply material or can comprise two or more layers which are either sealed together or separated to form a double wall container. Where the layers are sealed together, the material can comprise a laminated or extruded material. The laminated material comprises two or more separately formed layers that are subsequently secured together by an adhesive.

The extruded material comprises a single integral sheet that comprises two or more layers of different materials that can be separated by a contact layer. All of the layers are simultaneously co-extruded. One example of an extruded material that can be used in the present invention is the HyQ CX3-9 film available from HyClone Laboratories, Inc. out of Logan, Utah. The HyQ CX3-9 film is a three-layer, 9 mil cast film produced in a cGMP facility. The outer layer is a polyester elastomer coextruded with an ultra-low density polyethylene product contact layer. Another example of an extruded material that can be used in the present invention is the HyQ CX5-14 cast film also available from HyClone Laboratories, Inc. The HyQ CX5-14 cast film comprises a polyester elastomer outer layer, an ultra-low density polyethylene contact layer, and an EVOH barrier layer disposed therebetween. In still another example, a multi-web film produced from three independent webs of blown film can be used. The two inner webs are each a 4 mil monolayer polyethylene film (which is referred to by HyClone as the HyQ BM1 film) while the outer

barrier web is a 5.5 mil thick 6-layer coextrusion film (which is referred to by HyClone as the HyQ BX6 film).

The material is approved for direct contact with living cells and is capable of maintaining a solution sterile. In such an embodiment, the material can also be sterilizable such as by ionizing radiation. Examples of materials that can be used in different situations are disclosed in U.S. Pat. No. 6,083,587 which issued on Jul. 4, 2000 and U.S. Patent Publication No. US 2003-0077466 A1, published Apr. 24, 2003 which are hereby incorporated by specific reference.

In one embodiment, container 18 comprise a two-dimensional pillow style bag wherein two sheets of material are placed in overlapping relation and the two sheets are bonded together at their peripheries to form the internal compartment. Alternatively, a single sheet of material can be folded over and seamed around the periphery to form the internal compartment. In another embodiment, the containers can be formed from a continuous tubular extrusion of polymeric material that is cut to length and is seamed closed at the ends.

In still other embodiments, container 18 can comprise a three-dimensional bag that not only has an annular side wall but also a two dimensional top end wall and a two dimensional bottom end wall. Three dimensional containers comprise a plurality of discrete panels, typically three or more, and more commonly four or six. Each panel is substantially identical and comprises a portion of the side wall, top end wall, and bottom end wall of the container. Corresponding perimeter edges of each panel are seamed. The seams are typically formed using methods known in the art such as heat energies, RF energies, sonics, or other sealing energies.

In alternative embodiments, the panels can be formed in a variety of different patterns. Further disclosure with regard to one method of manufacturing three-dimensional bags is disclosed in United States Patent Publication No. U.S. 2002-0131654 A1 that was published Sep. 19, 2002 of which the drawings and Detailed Description are hereby incorporated by reference.

It is appreciated that container 18 can be manufactured to have virtually any desired size, shape, and configuration. For example, container 18 can be formed having a compartment sized to 10 liters, 30 liters, 100 liters, 250 liters, 500 liters, 750 liters, 1,000 liters, 1,500 liters, 3,000 liters, 5,000 liters, 10,000 liters or other desired volumes. Although container 18 can be any shape, in one embodiment container 18 is specifically configured to be complementary or substantially complementary to the chamber on container station 14 in which container 18 is received, as will be discussed below.

In any embodiment, however, it is desirable that when container 18 is received within the chamber on container station 14, container 18 is at least generally uniformly supported by container station 14. Having at least general uniform support of container 18 by container station 14 helps to preclude failure of container 18 by hydraulic forces applied to container 18 when filled with fluid.

Although in the above discussed embodiment container 18 has a flexible, bag-like configuration, in alternative embodiments it is appreciated that container 18 can comprise any form of collapsible container or semi-rigid container. Container 18 can also be transparent or opaque and can have ultraviolet light inhibitors incorporated therein.

Continuing with FIG. 2, formed on container 18 are a plurality of ports 30 at upper end 22 and a plurality of ports 31 and 32 on opposing sides of side 20 at lower end 24. Each of ports 30-32 communicate with compartment 28. Although only a few ports 30-32 are shown, it is appreciated that container 18 can be formed with any desired number of ports 30-32 and that ports 30-32 can be formed at any desired



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location on container 18. Ports 30-32 can be the same configuration or different configurations and can be used for a variety of different purposes. For example, ports 30 can be coupled with fluid lines for delivering media, cell cultures, and/or other components into container 18 and withdrawing gas from container 18. Ports 31 and/or 32 can be useful in withdrawing fluid from container 18 or can have other purposes.

Ports 30-32 can also be used for coupling probes to container 18. For example, when container 18 is used as a bioreactor for growing cells or microorganisms, ports 30-32 can be used for coupling probes such as temperatures probes, pH probes, dissolved oxygen probes, and the like. Examples of ports 30-32 and how various probes and lines can be coupled thereto is disclosed in U.S. Patent Publication No. 2006-0270036, published Nov. 30, 2006 and U.S. Patent Publication No. 2006-0240546, published Oct. 26, 2006, which are incorporated herein by specific reference. Ports 30-32 can also be used for coupling container 18 to secondary containers, to condenser systems, and to other desired fittings.

As also shown in FIG. 2, container assembly 16 can comprise a plurality of radially spaced apart alignment tabs 38 projecting from lower end 24 of container 18. In the embodiment depicted, each alignment tab 38 comprises a single tab welded to container 18 and having an opening 39 extending therethrough. In alternative embodiments, alignment tabs 38 can comprise a loop of material that bound an opening passing therethrough or can have other configurations that permit the tab to attach to a structure. As discussed below in greater detail, alignment tabs 38 can be used for proper positioning of container assembly 16 within container station 14.

In one embodiment of the present invention, container assembly 16 includes means for delivering a gas into the lower end of container 18. By way of example and not by limitation, container assembly 16 can comprise a sparger 34 positioned either on or mounted to lower end 24 of container 18 for delivering a gas to the fluid within container 18. As is understood by those skilled in the art, various gases are typically required in the growth of cells or microorganisms within container 18. The gas typically comprises air that is selectively combined with oxygen, carbon dioxide and/or nitrogen. However, other gases can also be used. The addition of these gases can be used to regulate the dissolved oxygen content and pH of a culture. A gas line 36 is coupled with sparger 34 for delivering the desired gas to sparger 34. Gas line 36 need not pass through lower end 24 of container 18 but can extend down from upper end 22 or from other locations.

Sparger 34 can have a variety of different configurations. For example, sparger 34 can comprise a permeable membrane or a fritted structure comprised of metal, plastic or other materials that dispense the gas in small bubbles into container 18. Smaller bubbles can permit better absorption of the gas into the fluid. In other embodiments, sparger 34 can simply comprise a tube, port, or other type opening formed on or coupled with container 18 through which gas is passed into container 18. In contrast to being disposed on container 18, the sparger can also be formed on or coupled with impeller 64 which is discussed below. Examples of spargers and how they can be used in the present invention are disclosed in U.S. Patent Publication Nos. 2006-0270036 and 2006-0240546 which were previously incorporated by reference. Other conventional spargers can also be used.

Container assembly 16 further comprises an impeller assembly 40. As depicted in FIG. 3, impeller assembly 40 comprises an elongated tubular connector 44 having a rotational assembly 48 mounted at one end and an impeller 64 mounted on the opposing end. More specifically, tubular con-

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connector 44 has a first end 46 and an opposing second end 48 with a passage 50 that extends therebetween. In one embodiment, tubular connector 44 comprises a flexible tube such as a polymeric tube. In other embodiments, tubular connector 44 can comprise a rigid tube or other tubular structure.

Rotational assembly 48 is mounted to first end 46 of tubular connector 44. Rotational assembly 48 comprises an outer casing 50 having an outwardly projecting flange 52 and a tubular hub 54 rotatably disposed within outer casing 50. A bearing assembly can be disposed between outer casing 50 and tubular hub 54 to permit free and easy rotation of hub 54 relative to casing 50. Likewise, one or more seals can be formed between outer casing 50 and tubular hub 54 so that during use an aseptic seal can be maintained between outer casing 50 and tubular hub 54 as tubular hub 54 rotates relative to outer casing 50.

Hub 54 has an interior surface 56 that bounds an opening 58 extending therethrough. As will be discussed below in greater detail, an engaging portion of interior surface 56 has a polygonal or other non-circular transverse cross section so that a driver portion of drive shaft 362 passing through opening 58 can engage the engaging portion and facilitate rotation of hub 54 by rotation of drive shaft 362. Hub 54 can also comprise a tubular stem 60 projecting away from outer casing 50. Hub 54 can couple with first end 44 of tubular connector 42 by stem 60 being received within first end 44. A pull tie, clamp, crimp or other fastener can then be used to further secure stem 60 to tubular connector 42 so that a liquid tight seal is formed therebetween. Other conventional connecting techniques can also be used.

Impeller 64 comprises a central hub 66 having a plurality of fins 68 radially outwardly projecting therefrom. It is appreciated that a variety of different numbers and configurations of fins 68 can be mounted on hub 66. Hub 66 has a first end 70 with a blind socket 72 formed thereat. Socket 72 typically has a noncircular transverse cross section, such as polygonal, so that it can engage a driver portion of drive shaft 362. Accordingly, as will be discussed below in greater detail, when a driver portion is received within socket 72, the driver portion engages with impeller 64 such that rotation of drive shaft 362 facilitates rotation of impeller 64.

In one embodiment, hub 66 and fins 68 of impeller 64 are molded from a polymeric material. In alternative embodiments, hub and fins 68 can be made of metal, composite, or a variety of other materials. If desired, an annular insert can be positioned within socket 72 to help reinforce hub 66. For example, the insert can be comprised of metal or other material having a strength property greater than the material from which hub 66 is comprised.

Impeller 64 can be attached to connector 42 by inserting first end 70 of hub 66 within connector 42 at second end 46. A pull tie, clamp, crimp, or other type of fastener can then be cinched around second end 46 of connector 42 so as to form a liquid tight sealed engagement between impeller 64 and connector 42.

Returning to FIG. 2, rotational assembly 48 is secured to container 18 so that tubular connector 42 and impeller 64 extend into or are disposed within compartment 28 of container 18. Specifically, in the depicted embodiment container 18 has an opening 74 at upper end 22. Flange 52 of outer casing 50 is sealed around the perimeter edge bounding opening 74 so that hub 54 is aligned with opening 74. Tubular connector 42 having impeller 64 mounted on the end thereof projects from hub 54 into compartment 28 of container 18. In this configuration, outer casing 50 is fixed to container 18 but hub 54, and thus also tubular connector 42 and impeller 64, can freely rotate relative to outer casing 50 and container 18.



As a result of rotational assembly 48 sealing opening 74, compartment 28 is sealed closed so that it can be used in processing sterile fluids.

As depicted in FIG. 3, impeller assembly 40 is used in conjunction with drive shaft 362. In general drive shaft 362 comprises a head section 364 and a shaft section 366 that can be coupled together by threaded connection or other techniques. Alternatively, draft shaft 362 can be formed as a single piece member or from a plurality of attachable sections. Drive shaft 362 has a first end 368 and an opposing second end 370. Formed at first end 368 is a frustoconical engaging portion 372 that terminates at a circular plate 374. Notches 376 are formed on the perimeter edge of circular plate 374 and are used for engaging drive shaft 362 with a drive motor assembly as will be discussed below.

Formed at second end 370 of drive shaft 362 is a driver portion 378. Driver portion 378 has a non-circular transverse cross section so that it can facilitate locking engagement within hub 66 of impeller 64. In the embodiment depicted, driver portion 378 has a polygonal transverse cross section. However, other non-circular shapes can also be used. A driver portion 380 is also formed along drive shaft 362 toward first end 368. Driver portion 380 also has a non-circular transverse cross section and is positioned so that it can facilitate locking engagement within the interior surface of hub 54 of rotational assembly 48.

During use, as will be discussed below in further detail, drive shaft 362 is advanced down through hub 54 of rotational assembly 48, through tubular connector 42 and into hub 66 of impeller 64. As a result of the interlocking engagement of driver portions 378 and 380 with hubs 66 and 54, respectively, rotation of drive shaft 362 by a drive motor assembly facilitates rotation of hub 54, tubular connector 42 and impeller 64 relative to outer casing 50 of rotational assembly 48. As a result of the rotation of impeller 64, fluid within container 18 is mixed.

It is appreciated that impeller assembly 40, drive shaft 362 and the discrete components thereof can have a variety of different configuration and can be made of a variety of different materials. Alternative embodiments of and further disclosure with respect to impeller assembly 40, drive shaft 362, and the components thereof are disclosed in U.S. patent application Ser. No. 12/697,771 filed Feb. 1, 2010 which is incorporated herein in its entirety by specific reference.

Returning to FIG. 1, container station 14 comprises a support housing 78 supported on a cart 80. Support housing 78 has a substantially cylindrical sidewall 82 that extends between an upper end 84 and an opposing lower end 86. Lower end 86 has a floor 88 (FIG. 6) mounted thereto. As a result, support housing 14 has an interior surface 90 that bounds a chamber 92. An annular lip 94 is formed at upper end 84 and bounds an opening 96 to chamber 92. As discussed above, chamber 92 is configured to receive container assembly 16 so that container 18 is supported therein.

Although support housing 78 is shown as having a substantially cylindrical configuration, in alternative embodiments support housing 78 can have any desired shape capable of at least partially bounding a compartment. For example, sidewall 82 need not be cylindrical but can have a variety of other transverse, cross sectional configurations such as polygonal, elliptical, or irregular. Furthermore, it is appreciated that support housing 78 can be scaled to any desired size. For example, it is envisioned that support housing 78 can be sized so that chamber 92 can hold a volume of less than 50 liters, more than 1,000 liters or any of the other volumes as discussed above with regard to container 18. Support housing 78 is typically made of metal, such as stainless steel, but can also

be made of other materials capable of withstanding the applied loads of the present invention.

With continued reference to FIG. 1, sidewall 82 of support housing 78 has a first side face 100 and an opposing second side face 102. An enlarged access 104 is formed on second side face 102 at lower end 86 so as to extend through sidewall 82. A door 106 is hingedly mounted to sidewall 82 and can selectively pivot to open and close access 104. A latch assembly 108 is used to lock door 106 in the closed position. An opening 110, which is depicted in the form of an elongated slot, extends through door 106. Opening 110 is configured to align with ports 32 (FIG. 2) of container assembly 16 when container station 14 is received within chamber 92 so that ports 32 project into or can otherwise be accessed through opening 110. In some embodiments, a line for carrying fluid or gas will be couple with port 32 and can extend out of chamber 29 through opening 110. As previously mentioned, any number of ports 32 can be formed on container 18 and thus a number of separated lines may pass out through opening 110. Alternatively, different types of probes, inserts, connectors or the like may be coupled with ports 32 which can be accessed through opening 110.

Turning to FIG. 4, similar to second side face 102, an enlarged access 114 is formed on first side face 100 at lower end 86 so as to extend through sidewall 82. A door 116 is hingedly mounted to sidewall 82 and can selectively pivot to open and close access 114. A latch assembly 118 is used to lock door 116 in the closed position. An opening 120, which is depicted in the form of an elongated slot, extends through door 116. Opening 120 is configured to align with ports 32 (FIG. 2) of container assembly 16 when container assembly 16 is received within chamber 92 and serves the same corresponding function as discussed above with regard to opening 110.

As shown in FIG. 1, door 106 has an exterior surface 107 that is substantially flush with the exterior surface of side wall 82 when door 106 is in the closed position. In contrast, as shown in FIG. 5, door 116 has a perimeter frame 128 that includes a first side rail 129, a spaced part second side rail 130, an upper rail 131 that extends between the upper ends of rails 129 and 130, and a lower rail 132 that extends between the lower ends of rails 129 and 130. Each of rails 129-132 has an inside face 134 that extends between an interior surface 136 and an exterior surface 138. Door 116 further includes a panel 140 having a front face 142 and an opposing back face 144. Panel 140 is mounted on or adjacent to inside face 134 of rails 129-132 so that back face 144 of panel 140 is disposed substantially flush with interior surface 80 of support housing 78 when door 116 is in the closed position. Panel 140 has opening 120 extending therethrough. As a result of the position of panel 140, a recess 146 is formed on door 116 that is bounded in part by front face 142 of panel 140 and inside face 134 of rails 129-132.

An elongated rack 148 is connected to and extends between inside faces 134 of side rails 129 and 130 so that rack 148 is retained within recess 146. In the depicted embodiment rack 148 comprises a flat bar that is curved along the length thereof. Alternatively, other support structures can also be used. Rack 148 is positioned so as to be slightly above or aligned with opening 120. Rack 148 is disposed within recess 148 to help protect it from damage during movement, shipping or use of container station 14. In alternative embodiments, rack 148 can project outside of recess 146, can be mounted on exterior faces of rails 129 and 130 or can be formed in a generally elongated U-shaped configuration and mounted on the exterior surface of door 116.



Rack **148** is used to support one or more removable hose supports **150**. As shown in FIG. **5**, each hose support **150** comprises an elongated shaft **152** having a first end **154** and an opposing second end **156**. Mounted at first end **154** is a conventional hose clamp **158**. Hose clamp **158** comprises a pair of resiliently flexible arms that can be manually pried apart. Once the hose is positioned between the arms, the arms resiliently press back toward each other so as to secure the hose therebetween. Other hose clamps or other structures capable of holding or securing a hose can also be used. Downwardly projecting from second end **156** of shaft **152** is a pair of spaced apart rigid arms **160** and **161** that bound a slot **162** therebetween. Hose support **150** is attached to rack **148** by sliding rack **148** into slot **162**. A set screw **164** can then be threaded through arm **160** to bias against rack **148** so as to secure hose clamp **150** to rack **148**. Other conventional mounting structures can also be used for removably securing hose support **150** to rack **148**.

Hose clamps **150** are used for supporting hoses that extend out of opening **120** and are coupled with corresponding ports **31** (FIG. **2**). Hose clamps **150** help keep the hoses organized and prevent unwanted kinking. It is appreciated that any number of hose clamps **150** can be attached to rack **148**. During shipping or movement of container station **14**, hose clamps **150** can be removed so that they are not damaged and do not form an obstruction.

Accesses **104** and **114** (FIGS. **1** and **4**) are in part provided so that when container assembly **16** is being inserted within chamber **92**, an operator can reach into chamber **92** through access **104** and/or **114** to help orientate and secure container assembly **16** within chamber **92** and to help align and/or feed various ports and tubes extends from container assembly **16** with or through corresponding openings **110**, **120**, and the like on support housing **78**. In alternative embodiments, it is appreciated that door **106** can be used on both accesses **104** and **114** or that door **116** can be used on both access **104** and **114**. In other embodiments, support housing **78** can be formed with only one of access **104** or **114** or that both access **104** and **114** can be eliminated and opening **110** and/or **120** can be formed directly on sidewall **82**.

Returning to FIG. **4**, a plurality of radially spaced apart alignment openings **168** extend through sidewall **82** of support housing **78** at lower end **86**. A catch **170** laterally projects from an exterior surface of sidewall **82** into alignment with each alignment opening **168**. As container assembly **16** is being inserted into chamber **92** of support housing **78**, before it is filled with fluid, container **18** is spread apart and alignment tabs **38** (FIG. **2**) of container assembly **16** are advanced through corresponding alignment openings **168** and secured to a corresponding catch **170**. This positioning helps ensure that container assembly **16** is properly positioned and spread apart so that container **18** fully and properly expands during filling with fluid as opposed to parts of container **18** being kinked or remaining folded during filling. It is appreciated that catches **170** can have a variety of different configuration and can also be in the form of straps, elastic cords or the like that can engage and secure tabs **38** to container station **14**.

As shown in FIG. **1**, support housing **78** can also comprise a handle **174** attached to an outwardly extending sidewall **82**. Handle **174** is shown having an elongated U-shaped configuration but can also have other designs. A plurality of vertically aligned observation slot **176** extend along the height of sidewall **82** and extend through sidewall **82** so as to communicate with chamber **92**. Observation slots **176** permit and easy verification of the level of fluid within container **18**.

Turning to FIG. **6**, floor **88** of support housing **78** has an enlarged central opening **176** into which a plate **178** is remov-

ably positioned. Plate **178** has a slot **180** that extends from a perimeter edge of plate **178** toward a center of plate **178**. As such, plate **178** has a generally C-shaped configuration. Plate **178** typically freely sits on floor **88** and can be removed by being pushed up into chamber **92**. During use, as container assembly **16** is lowered into chamber **92**, a user can push plate **178** out of opening **176** and reach up through opening **176** to grasp gas line **36**. Gas line **36** is then pulled down through opening **176** and sparger **34** (FIG. **2**) is directed towards opening **176**. Finally, gas line **36** passes into slot **180** and plate **178** is fitted within opening **176** so that sparger **34** rests on or is disposed adjacent to plate **178**.

In one embodiment of the present invention means are provided for regulating the temperature of the fluid that is contained within container **18** when container **18** is disposed within support housing **78**. By way of example and not by limitation, sidewall **82** can be jacketed so as to bound one or more fluid channels that encircle sidewall **82** and that communicate with an inlet port **184** and an outlet port **186**. A fluid, such as water or propylene glycol, can be pumped into the fluid channel through inlet port **184**. The fluid then flows in pattern around sidewall **82** and then exits out through outlet port **184**.

By heating or otherwise controlling the temperature of the fluid that is passed into the fluid channel, the temperature of support housing **78** can be regulated which in turn regulates the temperature of the fluid within container **18** when container **18** is disposed within support housing **78**. In an alternative embodiment, electrical heating elements can be mounted on or within support housing **78**. The heat from the heating elements is transferred either directly or indirectly to container **18**. Alternatively, other conventional means can also be used such as by applying gas burners to support housing **78** or pumping the fluid out of container **18**, heating the fluid and then pumping the fluid back into container **18**. When using container **18** as part of a bioreactor or fermenter, the means for heating can be used to heat the culture within container **18** to a temperature in a range between about 30° C. to about 40° C. Other temperatures can also be used.

Returning to FIG. **4**, cart **80** comprises a platform **190** having a top surface **192** and an opposing bottom surface **194**. In the depicted embodiment, platform **190** has a substantially triangular configuration. In alternative embodiments, however, platform **190** can be square, rectangular, circular, or of other polygonal or irregular configurations. Downwardly projecting from bottom surface **194** are a plurality of spaced apart wheels **196**. A plurality of spaced apart legs **198** extend between floor **88** of support housing **78** and top surface **192** of platform **190**. Legs **198** provide an open gap between support housing **78** and platform **190** so as to enable access to plate **178** (FIG. **6**) as previously discussed.

Attached to and downwardly projecting from platform **190** is a locking catch **200**. As perhaps better depicted in FIG. **6**, locking catch **200** comprises a vertically extending face plate **202** and a pair of arms **204A** and **204B** project back from opposing sides of face plate **202** in complementary diverging angles so as to extend in a generally V-shaped orientation. Arm **204A** has a first flange **206A** and a second flange **208A** orthogonally projecting from opposing upper and lower ends of arms **204A** so as to be disposed in substantially parallel planes. An engagement rod **210A** is secured to and extends between flanges **206A** and **206B** at a spaced apart location from arm **204A**. Similarly, flanges **206B** and **208B** extend from opposing upper and lower ends of arm **204B** and have an engagement rod **210B** extending therebetween. The operation and function of locking catch **200** will be discussed below in greater detail with regard to docking station **12**.



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As depicted in FIG. 7, docking station 12 comprises stand 218 which includes a base 220 having a frame assembly 222 upstanding therefrom and a plurality of wheels 224 downwardly projecting therefrom. More specifically, base 220 comprises a pair of spaced apart runners 266A and 226B 5 extending in parallel alignment. A first cross member 228 extends between runners 266A and 266B at a rearward end thereof while a second cross member 230 extends between runners 266A and 266B at a forward end thereof. A wheel 224 downwardly projects from each opposing end of each runner 10 266A and 266B. Frame assembly 222 comprises a plurality of spaced apart vertical risers 232 having a plurality of lateral supports 234 extending therebetween. A horizontal platform 236 is mounted on frame assembly 222 forward of and at an elevation above first cross member 228. A pair of spaced apart 15 hand rails 238A and 238B extend from corresponding runner 226A and 226B and connect with frame assembly 222.

Mounted on second cross member 230 of base 220 is a locking assembly 244. Locking assembly 244 comprises a housing 246 having a front face 248. As depicted in FIG. 8, 20 front face 248 comprises an outwardly flaring, substantially U-shaped receiver 250 having end faces 252A and 252B extending from the opposing ends thereof. Access slots 254A and 254B are formed on end faces 252A and 252B, respectively. Receiver 250 bounds a recess 256 of complimentary shape that is configured to receive face plate 202. Locking 25 assembly 244 further comprises a pair of engaging arms 258A and 258B. Each arm 258A and 258B has a first end 260 disposed within housing 246 and an opposing second end 262 that projects out through a corresponding access slot 254. 30 Engaging arms 258A and 258B have a notch 264A and 264B, respectively, that are opposingly facing.

Engaging arms 258A and 258B can be movably positioned between a locking position as shown in FIG. 8 wherein second end 262 of arms 258 pivot towards each other and a 35 release position wherein second end 262 of engaging arms 258 are pivoted away from each other. A mechanical assembly is used for moving engaging arms 258 between the two positions. The mechanical assembly includes an axel 266A secured to housing 246 and extending through first end 260 of 40 engaging arm 258A so that engaging arm 258A can pivot about axel 266A. A pivot plate 268A is secured to first end 260 of engaging arm 258A so as to also pivot about axel 266A. A linkage 270A has a first end 272A pivotally mounted to pivot plate 268A and an opposing second end 274A mounted to a 45 guide pin 276. Guide pin 276 can pivot within and slide along a guide slot 278 that is formed on a bracket 280. Bracket 280 is secured to housing 246. A corresponding axel 266B, pivot plate 268B, and linkage 270B are similarly coupled with engaging arm 258B. A lever 282 is pivotally mounted to 50 housing 246 or base 220 and includes a first end 284 coupled with guide pin 276 and an opposing second end 286 (FIG. 7). As a result of the mechanical linkage, manual manipulation of second end 286 of lever 282 pivots engaging arms 258A and 258B between the locking and release positions. Finally, 55 locking assembly 244 also includes a spring 288 resiliently extending between pivot plates 268A and 268B a location forward of axels 266A and 266B. As a result of this configuration, spring 288 functions to resiliently pivot second end 262 of engaging arms 258A and 258B towards each other. 60

During use, it is desirable to engage locking assembly 244 with locking catch 200 so that container station 14 is rigidly locked with docking station 12. This is accomplished by advancing locking catch 200 into recess 256 of locking 65 assembly 244. Locking catch 200 has a configuration complimentary to and is configured to nest within recess 256 so that the structures are self aligning as they couple together. As

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locking catch 200 advances into recess 256, engagement rods 210 strike against the inside face of engagement arms 258A and 258B, respectively. Because of the inward sloping of the faces, engagement arms 258A and 258B resiliently flex out- 5 ward against the resistant spring 288 as engagement rods 210 are advanced forward.

Finally, once engagement rods 210 are advanced to notches 264A and 264B, engagement arms 258 resiliently pivot inward thereby retaining engagements rods 210A and 210B 10 within notches 252A and 252B. In this position, container station 14 is rigidly secured to docking station 12. As discussed below in greater detail, in this position, docking station 12 can be used to facilitate mixing and other processing of fluid within container assembly 16. When it is desired to 15 separate container station 14 from docking station 12, lever 282 is moved so that engagement arms 258 are spread apart into the release position thereby releasing engagement with locking catch 200. It is appreciated that there are a variety of different types of locking systems that can be used for remov- 20 ably securing container station 14 to docking station 12.

Returning to FIG. 7, docking station 12 further comprises a drive motor assembly 300 coupled with stand 218 by an adjustable arm assembly 302. Drive motor assembly 300 is used in conjunction with drive shaft 362 (FIG. 3) and can be 25 used for mixing and/or suspending a culture or other solution within container 18 (FIG. 2). Turning to FIG. 9, drive motor assembly 18 comprises a housing 304 having a top surface 306 and an opposing bottom surface 308. An opening 310 extends through housing 304 from top surface 306 to bottom 30 surface 308. A tubular motor mount 312 is rotatably secured within opening 310 of housing 304. Upstanding from motor mount 312 is a locking pin 316. A drive motor 314 is mounted to housing 304 and engages with motor mount 312 so as to 35 facilitate select rotation of motor mount 312 relative to housing 304. Drive shaft 362 is configured to pass through motor mount 312 so that engaging portion 372 of drive shaft 362 is retained within motor mount 312 and locking pin 316 of motor mount 312 is received within notch 376 of drive shaft 40 362. As a result, rotation of motor mount 312 by drive motor 314 facilitates rotation of drive shaft 362. Further discussion of drive motor assembly 300 and how it engages with drive shaft 362 and alternative designs of drive motor assembly 300 are discussed in U.S. patent application Ser. No. 12/697,771 which was previously incorporated herein by specific refer- 45 ence.

Arm assembly 302 is used to adjust the position of drive motor assembly 300 and thereby also adjust the position of drive shaft 362. As depicted in FIG. 10, arm assembly 302 50 comprises a first housing 318 that is rigidly secured to stand 218. Slidably disposed within first housing 318 is an elongated first support 320. First housing 318 and first support 320 are orientated such that first support 320 can slide vertically up and down along a first axis 322 (FIG. 11). In one embodiment, axis 322 can extend orthogonally to a horizontal surface on which docking station 12 is disposed. In alternative 55 embodiments, first housing 318 and first support 320 can be disposed so that axis 322 is disposed at an angle in a range between 0° to about 30° relative to a horizontal surface. Other angles can also be used.

In one embodiment of the present invention, means are provided for selectively locking first support 320 to first hous- 60 ing 318 at different locations along axis 322. In one embodiment of the present invention, such means comprises holes 324 formed at spaced apart locations along first support 320 and a spring activated pin 326 mounted to first housing 318. By pulling 326 out pin 326, first support 320 is free to slide 65 vertically up and down along axis 322. By pushing the pin 326



in, pin 326 is received within a corresponding hole 324 so as to lock first support 320 in place. It is appreciated that any number of conventional clamps, pins, screws, latches, fasteners, or the like can be used for securing first support 320 to first housing 318. Indicia or markings 328 can be formed along the surface of first support 320 to indicate the relative position of first support 320.

First support 320 terminates at an upper end 330. Mounted on upper end 330 is a second housing 332. A second support 334 has a first end 352 and an opposing second end 354. First end 352 is slidably mounted on second housing 332 so that second support 334 can be positioned at various locations along a second axis 335. Second support 334 and second housing 332 are typically disposed so that second axis 335 is horizontally disposed and is orthogonal to first axis 322. In alternative embodiments, however, second axis 335 can be disposed at an angle in a range between 0° to about 30° relative to first axis 322. Other angles can also be used.

Rails are typically disposed within second housing 332 on which second support 334 slides. In alternative embodiments, a variety of alternative mechanism can be used to permit second support 334 to slide relative to second housing 332. In one embodiment of the present invention, means are provided for selectively locking second support 334 at different locations along second housing 332. By way of example and not by limitation, second housing 332 is shown having a top surface 336 having an elongated slot 338 formed along the length thereof. A spring actuated pin is disposed within slot 338 and extends through second support 334. A plurality of spaced apart holes are formed on the bottom surface of second housing 332 or along the rails or other structures disposed within second house 332. During use, when pin 340 is elevated, second support 334 is free to slide back and forth along second housing 332 along second axis 335. When pin 340 is pressed down, pin 340 is received within a hole to thereby lock pin 340 and second support 334 in place. Indicia 342 can be disposed on top surface 336 to identify predefined locations for second support 344.

A third support 346 is rotatably mounted to second end 354 of second support 334. Third support 346 is mounted so that it rotates about a third axis 348. Third axis 348 can be disposed in a horizontal plane and or in the same plane as second axis 335. Third axis can also be disposed at an angle in a range between about 0° to about 30° relative to second axis 335. Drive motor assembly 300 is secured to third support 346 such that rotation of third support 346 facilitates concurrent rotation of drive motor assembly 300.

One embodiment of the present invention also includes means for locking third support 346 at different angles about third axis 348. By way of example and not by limitation, a spring activated pin 350 is mounted on third support 346. When pin 350 is retracted, third support 346 is free to rotate about third axis 348. As pin 350 is advanced inward, it is received within one of a plurality of holes formed on second end 354 of second support 334. As a result, third support 346 is thereby precluded from further rotation. Other conventional fastening techniques can also be used.

In view of the foregoing, first support 320 can facilitate vertical movement of drive motor assembly 300, second support 334 can facilitate horizontal movement of drive motor assembly 300 and third support 346 can facilitate rotational movement of drive motor assembly 300. As a result, arm assembly 302 can be used to position drive motor assembly 300 and drive shaft 362 which extends there through in a variety of different locations and orientations. As a result, arm

assembly 302 enables docking system station 12 to be used with a variety of different sized and shaped container stations 14.

During use, container station 14 is wheeled to docking station 12 and/or docking station 12 is wheeled to container station 14 and the two are securely coupled together, as shown in FIG. 1, by engaging locking assembly 244 (FIG. 7) with catch 200 (FIG. 4). In this secure position, arm assembly 302 is used to properly position drive motor assembly 300 so that rotational assembly 48 (FIG. 2) can be coupled with drive motor assembly 300. Specifically, as depicted in FIG. 12, housing 304 of drive motor assembly 300 has an open access 384 that is recessed on a front face 386 so as to communicate with opening 310 extending through housing 304. Access 384 is in part bounded by a substantially C-shaped first side wall 388 that extends up from bottom surface 308, a concentrically disposed substantially C-shaped second side wall 390 disposed above first side wall 388 and having a diameter larger than first side wall 388, and a substantially C-shaped shoulder 392 extending between side walls 388 and 390. As shown in FIG. 2, a door 394 is hingedly mounted to housing 304 and selectively closes the opening to access 384 from front face 386. Returning to FIG. 12, door 394 is secured in a closed position by a latch 396. Positioned on first side wall 388 is a section 398 of a resilient and/or elastomeric material such as silicone. Other sections 398 of similar materials can also be positioned on first side wall 388 or the interior surface of door 394.

As depicted in FIG. 13, to facilitate attachment of rotational assembly 48 to housing 304, with door 394 rotated to an open position, rotational assembly 48 is horizontally slid into access 384 from front face 386 of housing 304 so that a support flange 400 radially outwardly extending from an upper end of rotational assembly 48 rests on shoulder 392 of access 384. Rotational assembly 48 is advanced into access 384 so that the passage extending through hub 54 of rotational assembly 48 aligns with the passage extending through motor mount 312 (FIG. 9). In this position, door 394 is moved to the closed position and secured in the closed position by latch 396. As door 394 is closed, casing 50 of rotational assembly 48 is biased against the one or more sections 398 (FIG. 12) of resilient material so as to clamp rotational assembly 48 within access 384 and thereby prevent unwanted rotational movement of casing 50 relative to housing 304 of drive motor assembly 300.

Once rotational assembly 48 is secured to drive motor assembly 300, drive shaft 362 can be advanced down through drive motor assembly 300 and into impeller assembly 40 so as to engage impeller 64. Once drive shaft 362 is properly positioned, drive motor assembly 300 is activated causing drive shaft 362 to rotate impeller 64 and thereby mix or suspend the fluid within container 18. When the processing is complete, drive shaft 362 is removed and rotational assembly 48 is separated from drive motor assembly 300. Container station 14 can then be separated from docking station 12 by releasing catch 200 from locking assembly 244. A second container station 14 can then be couple with docking station 12 in the same manner as discussed above. Where the second container station 14 is a different size or configuration or where the container assembly 16 coupled thereto is a different size or configuration, arm assembly 302 can be used to properly position drive motor assembly 300 at a potentially different location so that the new rotational assembly 48 can be coupled with drive motor assembly 300. Drive shaft 362 can then again be advanced down through drive motor assembly 300 and into impeller assembly 40 of the new container assembly 16.



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In view of the foregoing, it is appreciated that a single docking station **14** can be used with a variety of different container stations **14** and/or container assemblies **16** wherein the different container stations **14** and/or container assemblies **16** can be of different size and/or shape.

Depicted in FIG. **14** is an alternative embodiment of the present invention. In this embodiment drive motor assembly **300** operates with a container **404** that is an open top liner. Container **404** is positioned within chamber **92** of support housing **78** so that it drapes over annular lip **94** (FIG. **1**). This configuration can be used as a lower cost alternative for mixing non-sterile fluids. In this embodiment, rotational assembly **48** merely functions to secure impeller assembly **40** to drive motor assembly **300** so that it does not unintentionally slide off of drive shaft **362**. In alternative embodiments, because rotational assembly **48** is no longer forming a sealed fluid connection with the container, rotational assembly **48** can be substantially simplified. For example, as shown in FIG. **15**, rotational assembly **48** can be replaced by a clamp **406** that secures tubular connector **42** to drive shaft **362**. Further alternative embodiments with regard to impeller assembly **40** and how they can be attached to drive motor assembly **300** or drive shaft **362** are discussed in U.S. patent application Ser. No. 12/697,771 which was previously incorporated herein by specific reference.

Depicted in FIG. **16** is an alternative embodiment of an inventive mixing system **10A** incorporating features of the present invention. Like elements between systems **10** and **10A** are identified by like reference characters. In general, mixing system **10A** comprises docking station **12**, a container station **14A** that removeably docks with docking station **12**, a container assembly **16A** that is supported within container station **14A**, and drive shaft **362** (FIG. **3**) that extends between docking station **12** and container assembly **16A**.

As depicted in FIG. **17**, container assembly **16A** comprises container **18** having impeller assembly **40** attached thereto the same as in container assembly **16**. However, in contrast to container assembly **16** which was designed to function as part of a fermentor or bioreactor, container assembly **16A** is primarily designed for mixing and transporting fluids. As such, sparger **34** of container assembly **16** has been removed and replaced with a port **410** centrally secured on a floor **411** of container **18**. A drain line **412**, which is typically in the form of a flexible tube, is coupled to and extends from port **410**. A hose clamp **413**, as is known in the art, can be attached to drain line **412** for controlling the flow of fluid therethrough.

Container assembly **16A** also comprises a plurality of radially spaced apart alignment tabs **414** projecting from upper end **22** of container **18**. In the embodiment depicted, each alignment tab **414** comprises a single tab welded to container **18** and having an opening **415** extending therethrough. In alternative embodiments, alignment tabs **414** can comprise a loop of material that bound an opening passing therethrough or can have other configurations that permit the tab to attach to a structure. As will be discussed below in greater detail, tabs **414** can be used for proper positioning and supporting container assembly **16A** within container station **14A**. Fluid lines **416** are shown connected to ports **30** at upper end **22** and can also be used in container assembly **16**. It is appreciated that container assembly **16A** can have the same components, be made of the same materials, have the same sizes and shapes, and have all other alternatives as previously discussed above with regard to container assembly **16**. However, because container assembly **16** is commonly used for transporting fluids, container assembly **16A** typically has a volume

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in a range between about **10** liters to about **250** liters with about **25** liters to about **150** liters being more common. Other volumes can also be used.

Turning to FIG. **18**, container stations **14A** generally comprises a shipping vessel **420** removably mounted on a cart **422**. Cart **422** comprises a platform **424** having a top surface **426** and an opposing bottom surface **428**. In the depicted embodiment, platform **424** has a substantially square configuration. In alternative embodiments, however, platform **424** can be triangular, rectangular, circular, or of other polygonal or irregular configurations. Downwardly projecting from bottom surface **428** are a plurality of space apart wheels **430** which can be pivotally mounted to platform **424**. Also downwardly projecting from bottom surface **428** or otherwise attached to platform **424** is locking catch **200** which was previously discussed with regard to FIG. **6**. Locking catch **200** is mounted to cart **422** so that cart **422** can couple with docking station **12** in the same way that container station **14** can couple with docking station **12** as previously discussed with regard to FIGS. **7** and **8**.

As depicted in FIG. **19**, cart **422** further comprises a support base **432** and a plurality of spaced apart legs **434** that extend between platform **424** and support base **432**. In the embodiment depicted, support base **432** is shown as comprising a pair of crossed beams **433A** and **B** but in alternative embodiments can comprise a plate or any other structure that can support shipping vessel **420**. Mounted on and encircling support base **432** is an annular retaining wall **436**. Retaining wall **436** has an inside face **437** that extends from a bottom edge **439** to an opposing top edge **441**. A recess **443** is formed on top edge **441**. Inside face **437** bounds a cavity **438** extending above support base **432** into which shipping vessel **420** is received. Retaining wall **436** thus helps to prevent shipping vessel **420** from laterally sliding off of support base **432**. In alternative embodiments, it is appreciated that retaining wall **436** need not comprise a continuous encircling structure but can comprise a plurality of spaced apart posts or spaced apart sections of the depicted retaining wall **436**. In yet another alternative, retaining wall **436** can have a substantially C-shaped configuration.

Turning to FIG. **20**, cart **422** further comprises a pair of foldable handles **440A** and **440B**. Handle **440A** comprises a first handle portion **442** having a substantially L-shape configuration that extends out from one of legs **434** and terminates at a vertical riser **444**. Vertical riser has an inverted T-shaped slot **456** that extends down from a top edge thereof. Handle **440A** also comprises a second handle portion **448** that includes a post **450** slidably received within vertical riser **444**, an extension arm **452** orthogonally projecting from post **450**, and a hand grip **454** orthogonally projecting from extension arm **452**. A pin **446** radially outwardly projects from post **450** and is slid down the vertical section of slot **456** so as to be received within the horizontal section of slot **456**. Slot **456** forms a path along which pin **446** can travel so that second handle portion **448** can rotate laterally over a defined distance or be removed from first handle portion **442** so that second handle portion **448** is not obstructive. Handle **440B** has the same configuration as handle **440A** and thus functions in a similar manner.

As also shown in FIG. **20**, shipping vessel **420** comprises an annular side wall **470** having an interior surface **472** and an opposing exterior surface **474** that longitudinally extend between an upper end **476** and opposing lower end **478**. Interior surface **472** bounds a chamber **480**. An annular lip **482** formed at upper end **476** bounds an access opening to chamber **480**.



Turning to FIG. 21, although not required, in one embodiment, a base floor 484 is formed at bottom end 474 of side wall 470. In one embodiment, base floor 484 and side wall 470 combine to form a barrel having a cylindrical configuration. However, in alternative embodiments, side wall 470 need to be cylindrical but can have a square, polygonal, irregular, or any other desired cross sectional configuration. An access port 490 extends through side wall 470 at lower end 478. An annular sleeve 492 is disposed on side wall 470, such as by adhesive, thermal welding, integral molding, or the like, and projects into chamber 480. Sleeve 492 has an interior surface 494 which can be threaded. In turn, a plug 496 can have a threaded surface 498 such that plug 496 can be threaded into sleeve 492 for selectively closing access port 490. A polygonal post 499 or corresponding socket can be formed on plug 496 to enable plug 496 to be rotated by a tool. In alternative embodiments, plug 496 can be secured within access port 490 through a friction connection, bayonet connection, or any other type of conventional removable connection.

Positioned within chamber 480 is a floor insert 500. Floor insert 500 comprises an annular support wall 502 extending from a first end 504 to an opposing second end 506. A recess 508 is formed on second end 506 of support wall 502. Support wall 502 is configured to be freely passed down through chamber 480 until second end 506 rests on base floor 484 with sleeve 492 being received within recess 508. Floor insert 500 further comprises a support floor 510 that has a substantially frustoconical configuration. More specifically, support floor 510 has an interior surface 512 and an opposing exterior surface 514 that slope downwardly and radially inward from a first end 516 connected to first end 504 of support wall 502 to an opposing second end 518. Second end 518 bounds an annular opening 520. A plurality of support braces 522 extend between support wall 502 and support floor 510. As a result of support floor 510, chamber 480 is divided into an upper chamber 524 that extends from annular lip 482 to support floor 510 and a lower chamber 526 that extends from support floor 510 to base floor 484.

In one embodiment, floor insert 500 is removably positioned within chamber 480 so that it is supported on base floor 484. In an alternative embodiment, floor insert 500 can be secured within chamber 480 such as by welding, adhesive, or mechanical connection. In yet other alternative embodiments, support wall 502 can be eliminated and support floor 510 can be welded or otherwise secured directly to interior surface 472 of side wall 470. Another alternative design for shipping vessel 420 is disclosed in U.S. Pat. No. 7,153,021, which is incorporated herein by specific reference. Shipping vessel 420 is typically comprised of plastic but can be made of metal, composite, or other desired materials.

Returning back to FIG. 20, a retention ring 540 is used for securing container assembly 16A within upper chamber 524 of shipping vessel 420. Retention ring 540 comprises a substantially C-shaped ring body 542 that terminates at opposing ends having flanges 544A and 544B formed thereat. A fastener 546 extends through flanges 544A and B and can be used for selectively drawing and securing flanges 544A and B together. In one embodiment, fastener 546 can comprise a bolt and nut assembly. In alternative embodiments, fastener 546 can comprise a clamp, latch, or any other conventional fastener that achieve the desired objective.

Ring body 542 is typically in the form of a narrow band having an inside face 548 and an opposing outside face 550. A plurality of spaced apart catches 552 are mounted on inside face 548 of ring body 542. In one embodiment, each catch 552 comprises a elongated pin having a first end 554 that is

secured, such as by welding, at a central location on inside face 548. Each pin also comprises an opposing second end 556 that projects up above ring body 540. If desired, second end 556 of each pin can be rounded. Although not required, in one embodiment a plurality of spaced apart notches 558 are recessed on the bottom edge of ring body 542 such that the top of each notch 558 is disposed adjacent to first end 554 of a corresponding catch 552.

During use, fastener 546 is loosened so as to expand the size of ring body 542. Ring body 542 is then positioned on upper end 476 of shipping vessel 420 so that ring body 542 encircles exterior surface 474 of side wall 470. In this configuration, first end 554 of each catch 552 rests on top of annular lip 482 of side wall 470 so that retention ring 540 is properly positioned. If desired, a flange can be formed at first end 554 of each catch 552 for receiving annular lip 482. Notches 558 permit a visual inspection to ensure that ring body 542 is properly seated. Fastener 546 is then used to clamp retention ring 540 on side wall 470. As container assembly 16A (FIG. 17) is inserted within upper chamber 524, second end 556 of each catch 552 is passed through opening 415 of a corresponding alignment tab 414 so that container assembly 16A is supported and suspended within upper chamber 542 as shown in FIG. 16.

As shown in FIG. 22, during use shipping vessel 420 is manually positioned on cart 422 so that lower end 478 is received within retaining wall 436. Shipping vessel 420 is oriented so that access port 490 on shipping vessel 420 is aligned with recess 443 on retaining wall 436. Either before or after removably positioning shipping vessel 420 on cart 422, retention ring 540 is removably secured to upper end 476 of shipping vessel 420 as discussed above. An empty container assembly 16A (FIG. 17) is then positioned within upper chamber 524 of shipping vessel 420 so that catches 552 pass through openings 415 in alignment tabs 414 (FIG. 16).

Plug 496 can then be removed and an operator can reach through access port 490 and guide drain line 412 (FIG. 17) down through opening 520 of shipping vessel 420 (FIG. 21) and into lower chamber 526 where drain line 412 is temporarily stored. Port 410 of container assembly 16A (FIG. 17) can also be pulled down and positioned at or adjacent to opening 520 of shipping vessel 420 so that container assembly 16A is properly positioned within upper chamber 524 of shipping vessel 420. If desired, plug 496 can be then reinserted. In alternative embodiments, it is appreciated that retention ring 540 is not required. In this embodiment, container assembly 16A is unfolded and freely positioned within upper chamber 524 of shipping vessel 420. As container assembly 16A is filled with fluid, additional care must be taken to adjust container assembly 16A so that it remains properly positioned and is not kinked or folded.

Next, cart 422 is coupled with docking station 12 as depicted in FIG. 16. This is accomplished by locking catch 200 (FIG. 18) on cart 422 coupling with locking assembly 244 (FIG. 7) on docking station 12 in the same way that container assembly 14 couples with docking station 12 as previously discussed. It is appreciated that docking station 12 and/or cart 14 can be moved as part of this docking process. Once docking station 12 and cart 422 are securely coupled together, rotational assembly 48 (FIG. 17) of container assembly 16A is coupled with drive motor assembly 300 as previously discussed and shown in FIG. 16. Depending on the size of container station 14A, it may be necessary to adjust the vertical height or orientation of drive motor assembly 300 as previously discussed.

Next, drive shaft 362 (FIG. 3) is advanced down through drive motor assembly 300 and into impeller assembly 40 as



also previously discussed. Depending on the size of Either prior to or after the insertion of drive shaft 362, fluid is delivered into compartment 28 of container assembly 16A through one of fluid lines 416 (FIG. 17). Drive motor assembly 300 can then be activated to mix the components within container assembly 16A. Once the desired processing is complete, drive shaft 362 can be removed and cart 422 separated from docking station 12. Because container assembly 16A now contains fluid and is fully supported by side wall 470 and support floor 510 of shipping vessel 420 (FIG. 21), the retention ring 540 can be removed from shipping vessel 420 and container assembly 16A. Fluid lines 416 can be coiled and placed on top of container 18 within upper chamber 524. A lid 564, as shown in FIG. 23, can then be removably secured to upper end 476 of shipping vessel 420 so as to close off the opening thereof. If desired, lid 564 can be secured to shipping vessel 420 by fasteners, straps, clamps, or the like.

With lid 564 secured, shipping vessel 420 can be removed from cart 422. Shipping vessel 420, containing container assembly 16A with fluid therein, is then often moved to a temporary storage room. Where the fluid is media or other fluid that should be refrigerated, the storage room can be a cold room. When needed, shipping vessel 420 can be shipped, such as through a truck, train, airplane, ship or the like, to a customer, related facility, end user, or any other desired destination. Again, where needed, the shipping vehicle can have a refrigerated compartment for carrying shipping vessel 420. In alternative embodiments, it is appreciated that shipping vessel 420 can remain on cart 422 and the entire assembly can be stored and/or shipped. Once shipping vessel 420 reaches the desired destination, it is then placed on a second cart 422 located at the destination which second cart 422 is then coupled with a second docking station 12 located at the destination. Either before or after coupling with second docking station 12, lid 564 is removed. Rotational assembly 48 is then coupled with drive motor assembly 300 and drive shaft 362 is coupled therewith as previously discussed with regard to FIG. 16. If needed, the height or orientation of drive motor assembly 300 can be adjusted. Drive motor assembly 300 can then be activated to mix or resuspend fluids contained within container assembly 16A. Further processing of the fluid within container assembly 16A, such as adding additional components, can then also occur. Either while coupled with the second docking station 12 or after being removed therefrom, plug 496 can be removed and drain line 412 (FIG. 17) passed out through access port 490 (FIG. 21) and coupled with a further container or fluid line for transferring the fluid out of container assembly 16A. Once the fluid has been used, the container assembly 16A can be disposed of and shipping vessel 420 returned to the original location for reuse with a new container assembly 16A.

It is appreciated that the inventive system provides a modular system wherein standardized components, such as docking station 12 and cart 422, can be located at a number of different locations. Shipping vessel 420 can then be easily transported between the different locations and the fluid therein mixed or resuspended along with other processing without having to transfer the fluid to different containers. This helps to ensure sterility while minimizing costs and effort in performing the desired processing. The inventive system and method also permits reuse of shipping vessel 420 and disposal of container assembly 16 without the requirement for any washing or sterilization.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of

the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A method for shipping a fluid, the method comprising: removably securing a retention ring to a shipping vessel that bounds a chamber, the retention ring having a plurality of catches disposed thereon;

inserting a collapsible bag within the chamber of the shipping vessel so that a plurality of alignment tabs secured to the collapsible bag are removably secured to corresponding catches of the retention ring;

dispensing a fluid into a compartment of the collapsible bag, the shipping vessel being removably positioned on a movable first cart such that a lower end of the shipping vessel is supported on the first cart;

coupling the first cart directly to a first docking station, the first docking station comprising a stand and a first drive motor assembly mounted thereon;

mixing the fluid within the compartment of the collapsible bag by using the first drive motor assembly to rotate a drive shaft extending between the first drive motor assembly and the collapsible bag, the drive shaft passing into the chamber of the shipping vessel through an opening formed at an upper end of the shipping vessel, the upper end of the shipping vessel being disposed above the lower end of the shipping vessel;

separating the first cart from the first docking station;

removing the shipping vessel containing the collapsible bag and fluid from the first cart;

shipping the shipping vessel removed from the first cart and containing the collapsible bag and fluid to a second location;

positioning the shipping vessel on a movable second cart; coupling the second cart to a second docking station, the second docking station comprising a stand and a second drive motor assembly mounted thereon; and

mixing the fluid within the compartment of the collapsible bag by using the second drive motor assembly to rotate a drive shaft extending between the second drive motor assembly and the collapsible bag.

2. The method as recited in claim 1, wherein the shipping vessel comprises a plastic barrel.

3. The method as recited in claim 1, where in the fluid comprises a media, buffer or reagent.

4. The method as recited in claim 1, further comprising securing a lid to the shipping vessel prior to shipping the shipping vessel, the lid being completely removable from the shipping vessel.

5. The method as recited in claim 1, wherein the step of mixing the fluid comprises:

advancing the drive shaft consecutively through a portion of the first drive motor assembly, through a hub rotatably mounted on the collapsible bag, and into an elongated tubular connector, the tubular connector having the hub mounted on a first end and an impeller mounted on an opposing second end; and

activating the first drive motor assembly so that the first drive motor assembly rotates the drive shaft which in turn rotates the impeller within the compartment of the collapsible bag.

6. The method as recited in claim 1, further comprising removing the retention ring from the shipping vessel prior to shipping the shipping vessel to the second location.

7. A fluid mixing system comprising:

(i) a cart comprising:



- a frame;  
 a plurality of wheels mounted to frame; and  
 a locking catch coupled to the frame;
- (ii) a shipping vessel removably positioned on the frame of the cart such that a lower end of the shipping vessel is supported on the cart, the shipping vessel comprising:  
 an encircling sidewall bounding a chamber and extending between an upper end and an opposing lower end;  
 a support floor disposed within the chamber and dividing the chamber into an upper compartment and a lower compartment;  
 an opening extending through the support floor so as to provide communication between the upper compartment and the lower compartment; and  
 an access port extending through the sidewall at the lower end thereof so as to communicate with the lower compartment;
- (iii) a container assembly comprising:  
 a collapsible bag bounding a compartment, the collapsible bag being at least partially disposed within the upper compartment of the chamber of the shipping vessel;
- (iv) a docking station comprising:  
 a stand;  
 a locking assembly secured to the stand, the locking assembly engaging the locking catch of the cart so that the cart is releasably secured to the docking station; and  
 a drive motor assembly mounted to the stand; and
- (v) an elongated drive shaft removably coupled with the drive motor assembly and removably coupled with a mixing element located within the compartment of the collapsible bag, the drive shaft passing into the chamber of the shipping vessel through an opening formed at an upper end of the shipping vessel, the upper end of the shipping vessel being disposed above the lower end of the shipping vessel, the drive motor assembly being configured to rotate the drive shaft.
- 8.** The fluid mixing system as recited in claim 7, wherein the container assembly further comprises:  
 a rotational assembly comprising a casing mounted to the collapsible bag and a hub rotatably mounted to the casing, the hub having a passageway extending through;  
 the mixing element comprising an impeller; and  
 an elongated tubular connector extending between the hub and impeller, the drive shaft passing consecutively through the hub and into the tubular connector.
- 9.** The fluid mixing system as recited in claim 7, wherein the cart further comprises:  
 a plurality of legs upstanding from the frame; and  
 a support secured to the legs, the shipping vessel resting on the support.
- 10.** The fluid mixing system as recited in claim 7, wherein the shipping vessel comprises a plastic barrel.
- 11.** The fluid mixing system as recited in claim 7, further comprising a retention ring removably secured to the shipping vessel, the collapsible bag being removably secured to the retention ring.
- 12.** The fluid mixing system as recited in claim 7, further comprising a base floor disposed at the lower end of the sidewall so that the lower compartment is bounded between the support floor and the base floor.
- 13.** The fluid mixing system as recited in claim 7, further comprising a drain line extending from the collapsible bag,

the drain line or collapsible bag passing through the opening on the support floor, the drain line passing through the access port.

**14.** The method for shipping a fluid as recited in claim 1, wherein the drive shaft extending from the first drive motor engages an impeller disposed within the collapsible bag.

**15.** The method for shipping a fluid as recited in claim 1, wherein the step of mixing the fluid within the compartment of the collapsible bag by using the first drive motor assembly includes the drive shaft passing into the chamber of the shipping vessel through an opening formed at an upper end of the shipping vessel.

**16.** The method for shipping a fluid as recited in claim 1, wherein the step of mixing the fluid within the compartment of the collapsible bag by using the first drive motor assembly includes removably coupling the draft shaft to the first drive motor and removably coupling the draft shaft to a mixing element located within the compartment of the collapsible bag.

**17.** The method for shipping a fluid as recited in claim 1, wherein the shipping vessel comprises:

an encircling sidewall bounding the chamber and extending between an upper end and an opposing lower end;

a support floor disposed within the chamber and dividing the chamber into an upper compartment and a lower compartment, the collapsible bag being at least partially disposed within the upper compartment;

an opening extending through the support floor so as to provide communication between the upper compartment and the lower compartment;

a base floor disposed at the lower end of the sidewall so that the lower compartment is bounded between the support floor and the base floor; and

an access port extending through the sidewall at the lower end thereof so as to communicate with the lower compartment.

**18.** A method for shipping a fluid, the method comprising:  
 removably securing a retention ring to a shipping vessel that bounds a chamber, the retention ring having a plurality of catches disposed thereon;

inserting the collapsible bag within the chamber of a shipping vessel so a plurality of alignment tabs secured to the collapsible bag are removably secured to corresponding catches of the retention ring;

dispensing a fluid into a compartment of the collapsible bag, the shipping vessel being removably positioned on a movable first cart;

coupling the first cart directly to a first docking station, the first docking station comprising a stand and a first drive motor assembly mounted thereon;

mixing the fluid within the compartment of the collapsible bag by using the first drive motor assembly to rotate a drive shaft extending between the first drive motor assembly and the collapsible bag;

separating the first cart from the first docking station;

removing the shipping vessel containing the collapsible bag and fluid from the first cart;

shipping the shipping vessel removed from the first cart and containing the collapsible bag and fluid to a second location;

removing the retention ring from the shipping vessel prior to shipping the shipping vessel to the second location; and

mixing the fluid within the compartment of the collapsible bag in the shipping vessel at the second location.



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19. The method for shipping a fluid as recited in claim 18, wherein the step of mixing the fluid at the second location comprises:

positioning the shipping vessel on a movable second cart; coupling the second cart to a second docking station, the second docking station comprising a stand and a second drive motor assembly mounted thereon; and

mixing the fluid within the compartment of the collapsible bag by using the second drive motor assembly to rotate a drive shaft extending between the second drive motor assembly and the collapsible bag.

20. A method for shipping a fluid, the method comprising: dispensing a fluid into a compartment of a collapsible bag, the collapsible bag being positioned within a chamber of a shipping vessel, the shipping vessel being removable positioned on a movable first cart, the shipping vessel comprising:

an encircling sidewall bounding the chamber and extending between an upper end and an opposing lower end;

a support floor disposed within the chamber and dividing the chamber into an upper compartment and a lower compartment, the collapsible bag being at least partially disposed within the upper compartment;

an opening extending through the support floor so as to provide communication between the upper compartment and the lower compartment; and

an access port extending through the sidewall at the lower end thereof so as to communicate with the lower compartment;

coupling the first cart directly to a first docking station, the first docking station comprising a stand and a first drive motor assembly mounted thereon;

mixing the fluid within the compartment of the collapsible bag by using the first drive motor assembly to rotate a drive shaft extending between the first drive motor assembly and the collapsible bag;

separating the first cart from the first docking station;

removing the shipping vessel containing the collapsible bag and fluid from the first cart;

shipping the shipping vessel removed from the first cart and containing the collapsible bag and fluid to a second location;

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mixing the fluid within the compartment of the collapsible bag in the shipping vessel at the second location.

21. A fluid mixing system comprising:

(i) a cart comprising:

a frame;

a plurality of wheels mounted to frame; and

a locking catch coupled to the frame;

(ii) a shipping vessel removably positioned on the frame of the cart, the shipping vessel comprising:

an encircling sidewall bounding the chamber and extending between an upper end and an opposing lower end;

a support floor disposed within the chamber and dividing the chamber into an upper compartment and a lower compartment;

an opening extending through the support floor so as to provide communication between the upper compartment and the lower compartment; and

an access port extending through the sidewall at the lower end thereof so as to communicate with the lower compartment;

(iii) a container assembly comprising:

a collapsible bag bounding a compartment, the collapsible bag being at least partially disposed within the upper compartment of the chamber of the shipping vessel;

(iv) a docking station comprising:

a stand;

a locking assembly secured to the stand, the locking assembly engaging the locking catch of the cart so that the cart is releasably secured to the docking station; and

a drive motor assembly mounted to the stand; and

(v) an elongated drive shaft removably coupled with the drive motor assembly and removably coupled with a mixing element located within the compartment of the collapsible bag, the drive shaft passing into the chamber of the shipping vessel through an opening formed at an upper end of the shipping vessel, the drive motor assembly being configured to rotate the drive shaft.

\* \* \* \* \*



UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 9,314,751 B2  
APPLICATION NO. : 12/986701  
DATED : April 19, 2016  
INVENTOR(S) : Goodwin et al.

Page 1 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**In the Drawings**

Sheet 1, replace Fig. 1 as shown on the attached sheet, where reference number “107” has been added

Sheet 7, Fig. 7, replace reference number “226A” with --266A--

Sheet 20, replace Fig. 20 as shown on the attached sheet, wherein reference number “546” has been added

**In the Specification**

Column 1

Line 42, change “dispending the fluid” to --dispensing the fluid--

Line 55, change “minimize in risk” to --minimize the risk--

Column 2

Line 14, change “partially disassembly” to --partially disassembled--

Column 3

Line 2, change “and/or where is solution” to --and/or where the solution--

Column 4

Line 11, change “container 18 comprise” to --container 18 comprises--

Column 5

Line 27, change “material that bound” to --material that bounds--

Column 6

Line 28, change “to tubular connect 42” to --to tubular connector 42--

Signed and Sealed this  
Twenty-fourth Day of October, 2017



Joseph Matal

*Performing the Functions and Duties of the  
Under Secretary of Commerce for Intellectual Property and  
Director of the United States Patent and Trademark Office*

Column 7

Line 39, change “different configuration” to --different configurations--

Column 8

Line 16, change “will be couple” to --will be coupled--

Column 9

Line 32, change “tubes extends” to --tubes extending--

Line 55, change “different configuration” to --different configurations--

Line 62, change “observation slot 176” to --observation slots 176--

Line 64, change “permit and easy verification” to --permit easy verification--

Column 10

Line 65, change “rod 21 OB” to --rod 210B--

Column 11

Line 5, change “226B” to --266B--

Lines 16-17, change “runner 226A and 226B” to --runners 266A and 266B--

Column 12

Line 66, change “By pulling 326 out pin 326” to --By pulling out pin 326--

Column 13

Line 44, change “plane and or in” to --plane and/or in--

Column 14

Line 57, change “can then be couple” to --can then be coupled--

Column 15

Line 58, change “and supporting container” to --and supporting of container--

Column 16

Line 4, change “container stations” to --container station--

Line 12, change “plurality of space apart” to --plurality of spaced apart--

Column 17

Line 6, change “need to be” to --need not be--

Line 60, change “blot and nut” to --bolt and nut--

Line 67, change “comprises a elongated” to --comprises an elongated--

Column 18

Line 33, change “is then position” to --is then positioned--

Column 19

Line 29, change “the entirely assembly” to --the entire assembly--

**CERTIFICATE OF CORRECTION (continued)**  
**U.S. Pat. No. 9,314,751 B2**

In the Claims

Column 23

Line 15, change "being removable" to --being removably--



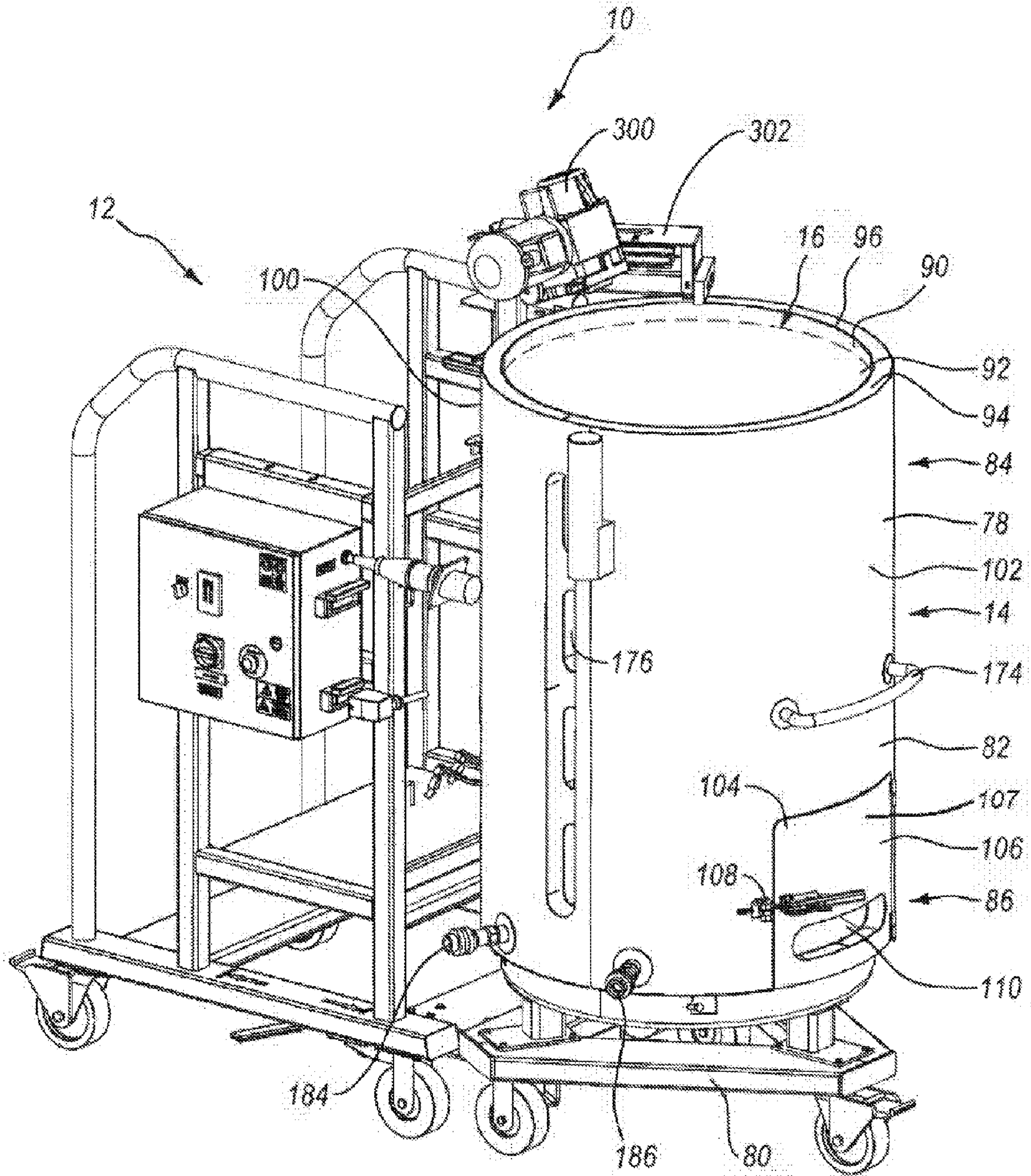


Fig. 1



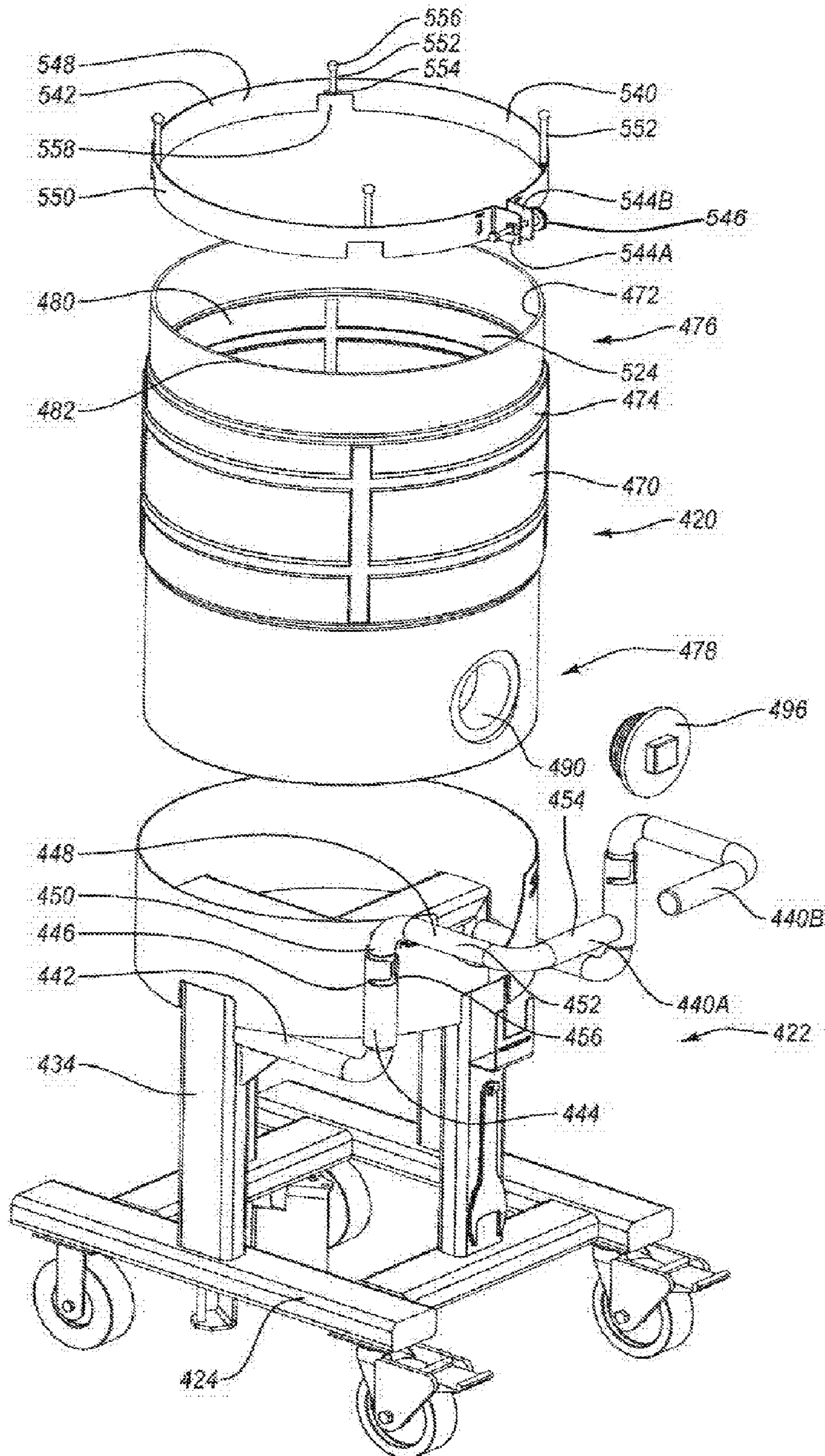


Fig. 20